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FLIGHT

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The AIRCRAFT ENGINEER AND AIRSHIPS

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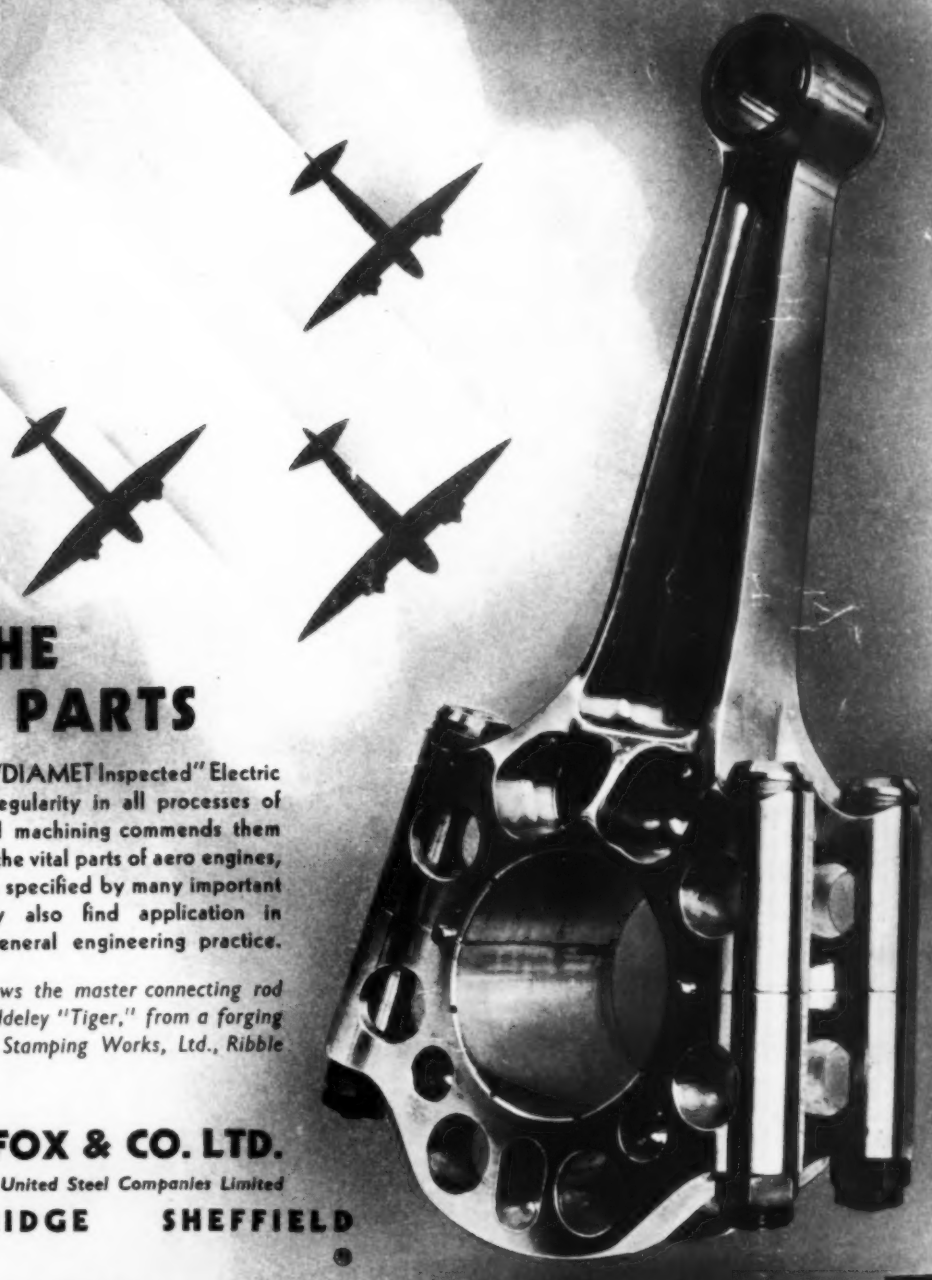
1830 XXIII



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FLIGHT

The AIRCRAFT ENGINEER AND AIRSHIPS

FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

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The Outlook

Overseas Supplies

ONE cannot help wondering to what extent the Government's decision to let Earl Winterton state in the House that "Definite exploratory action is being taken in regard to the possibility of the supply of aircraft for the Royal Air Force, both from the United States and from Canada," was influenced by the negotiations between Sir Thomas Inskip and the trade unions. By admitting the need for such action the Government may have intended to impress upon all concerned the urgent need for aircraft production, hoping thereby to convince the trade unions of the seriousness of the situation. It is difficult to believe that the Government really seriously contemplates ordering aircraft from the United States.

Obviously the time factor would not allow the building of aircraft of British design in American factories, and the only alternative would be to order American types. The most logical selection for such a hypothetical order would be the Boeing four-engined bomber, a type of military aircraft not hitherto produced in this country. But even if the type were considered entirely suitable for British requirements, it is doubtful that the American Army Air Corps would look with favour on possible delays in supplying its own needs. In any case, our own factories can, if the Air Ministry will do its share by agreeing to such reorganisation as is needed, supply four-engined bombers more than the equal of the Boeings.

Canada is another matter entirely. It is the one country of the British Commonwealth which is fairly safe from bombing, and thus factories in Canada could produce, even in time of war, without fear of dislocation by direct and indirect effects of air raids. Already the Canadian Fairchild company is planning production of bombers somewhat of the Bristol Blenheim type. One or two British aircraft companies have branches in Canada and could expand if required to do so. The Noorduyn concern has proved its ability to produce good aircraft, and is financed entirely by Canadian capital, although the head of the firm is a Dutchman who spent many years in England and afterwards in America. Several Grummans have been completed by the Canadian Car and Foundry Co. Another big concern is active at Toronto.

Transport is the main objection, but as the Falmouth Committee came to the somewhat surprising conclusion that fuel oils transported by convoys were less vulnerable than factories at home for the production of fuel oils, a view apparently accepted by the Government, perhaps the same argument applies to aircraft transported by sea from Canada. If need be, it would be possible, although probably not economical, to fly the machines across if Canadian production were to consist largely in long-range bombers, which could be given extra tankage.

Be that as it may, there is a great deal to be said for locating large aircraft factories in Canada. The money would "stay in the family," and the factories would be to all intents and purposes immune from bombing attacks.

Getting Somewhere

IT is with considerable pleasure that *Flight* is able to place before its readers this week a summary of an article by Professor H. Focke on his helicopter work. It is no exaggeration to say that the F.W.61 marks a tremendous step forward in the design of direct-lift aircraft. That it still carries only the pilot, on an engine of 160 h.p., and that its cross-country speed is no more than 76 m.p.h. in no way detracts from the merits of the long and painstaking work which resulted in its production. For the first time in history a direct-lift machine has successfully overcome the two great bugbears which have hitherto held back progress; lack of control and a reasonable ceiling. By her flight inside the Deutschlandhalle in Berlin some time ago Fräulein Hanna Reitsch quite definitely proved the former, as we have already pointed out in *Flight*. The second was demonstrated some time ago when the Focke-Wulf test pilot Rohlfs reached a height of 8,000ft.

The difficulty of getting a helicopter "upstairs" has been due, in the past, to poor efficiency of the lifting screws, which resulted in a rather excessive power being required to get good climb. Most experimental helicopters built hitherto have suffered from too inefficient lifting screws and too weak engines. They have managed to get off the ground, it is true, but their ceiling has been a few feet. This apparent cussedness of helicopters can be traced to the fact that "ground effect" is very pronounced. So much so

THE OUTLOOK (CONTINUED)

that a machine may have ample lift when its wheels are but a few feet above the ground, but as soon as the height between rotor and ground is increased to a little more than the rotor diameter, the ground effect disappears, and there is a great falling off in lift. Fortunately, the effect is beneficial in the oposite direction in that there is a great deal of "cushioning" when the machine is landing.

For fairly obvious reasons Professor Focke does not disclose the mechanical details of his incidence mechanism, but flight tests have shown that the time lag between direct-lift flight and gliding flight need not be more than two seconds, so obviously the mechanism, whatever it is, is effective.

Already the F.W.61 holds helicopter records with 1 hour 20 mins. duration, 68 miles distance, 8,000ft. altitude and 76 m.p.h speed. The rest is a matter of logical development.

The Long View

AFTER perusing Mr. Miles's project for a long-range passenger-carrier no one can accuse British aircraft designers of lack of imagination. In his "X" design Mr. Miles has incorporated all that modern knowledge can suggest. The layout, illustrated on this page, is an approach to the *Nurflügel* (all-wing) aircraft visualised more than twenty years ago by the late Professor Junkers, who actually took out patents to cover his ideas.

The attraction of the all-wing type of aircraft is, of course, that the maximum L/D ratio is that of the familiar wing model tested in the wind tunnel, which may well reach a value of twenty or more, whereas even a very clean aeroplane with fuselage and tail rarely reaches a maximum L/D of more than 15.

As has frequently been pointed out in *Flight*, an aeroplane flies most economically at the speed corresponding to maximum L/D, but, unfortunately, this ratio occurs closer to the minimum than to the maximum speed, so that unless the wing loading is high, the cruising speed is likely to be disappointingly low, and it is usually necessary to fly at some greater speed, at which the L/D ratio is less good.

In the Miles "X" design a compromise has been established, in which the fuselage and tail of the orthodox aircraft have been retained, but the wing thickness near the body has been made so great that the wing root merges smoothly into the curves of the fuselage. Many years ago the Westland Aircraft Works built a monoplane to the ideas of one Woyevodsky, in which something of the same sort was attempted, although the two machines are not comparable because in the Woyevodsky design the fuselage was deliberately made of lifting section, the idea being that it should carry its share of the load. That machine crashed on its first test flight, seriously injuring Capt. Keep, and the experiment was not repeated.

That Mr. Miles has achieved real improvement in efficiency in his "X" design is shown by the fact that when the wing loading is increased to some 35 pounds per square foot, the range goes up to well over 4,000 miles in still air, and that at a cruising speed of about 275 m.p.h. It is very much to be hoped that Air Ministry assistance will be found for building at least the "flying scale model" suggested by Mr. Miles. The experiment is one which ought to be made.

Naval Views of the Air

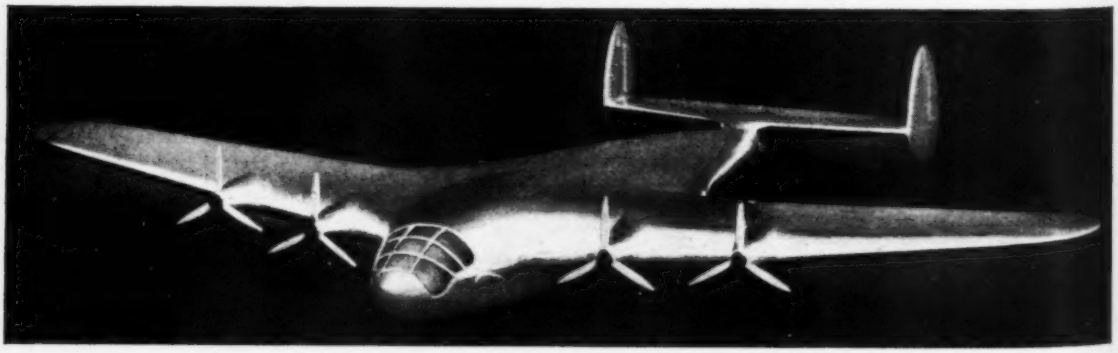
IT is always interesting to learn what naval men think of aircraft, and it has become more interesting than ever now that the Admiralty has been given complete control of its Air Arm. The articles in the 1938 issue of *Brassey's Naval Annual*, which has just been published, are therefore particularly worthy of study.

In this, as in previous editions of the *Annual*, it is evident that naval opinion is not unanimous on all points. For instance, one writer who signs himself "Securus" says that aircraft are able to a considerable extent to deprive the submarine of its greatly prized invisibility. On another page "Observer" writes that submarines always have been and always will be very difficult to see from the air, and that it is a misuse of aircraft to attempt to search for them submerged. Can it be that the former writer is thinking of the Mediterranean and the latter of the murky waters of the North Sea?

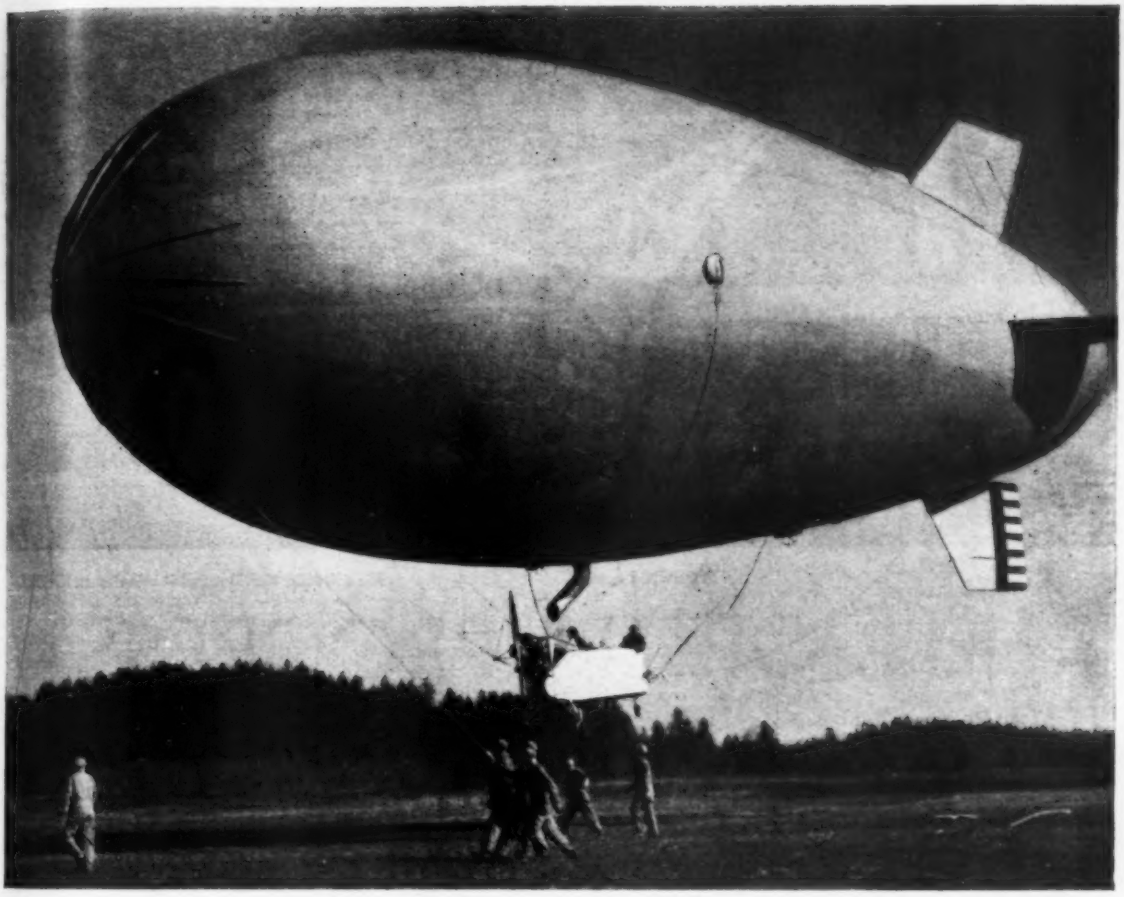
Again, "Observer" holds that shore-based aircraft cannot carry out any extensive patrol of the ocean routes, and asserts that to patrol at a radius of 250 miles over an arc of 180 degrees would require 40 aircraft in action and a total of 240 to provide a system of reliefs. As against this, the chapter on Foreign Fleet Air Arms states that the U.S. Navy maintains large flying boats of great endurance to patrol the vast triangle between the bases of Hawaii, the Aleutian Islands, and the Canal Zone. The snag in "Observer's" calculations probably is that he insists that his flying boats must not be more than 20 miles apart, and seems to visualise them as standing still when they have reached their position on the arc. Actually they would quest to and fro, and so a much smaller number than 40 would suffice.

The Larger Issues

THE two most important questions to which one would like to know the answers are: What will be the effect of aircraft on sea communications, and what will be their effect on fleet actions? It is agreed on all hands that harbours and naval bases will be less secure than they have been in the past. When aircraft can attack either they may do much destruction, and this fact tells most heavily against the stronger naval Power, and



NOT-SO-UNKNOWN QUANTITY: A wind-tunnel model of the projected 300-m.p.h. Miles X.2 four-engined transport, some comments on which appear above. Although the layout is unorthodox in a number of senses no new problems in stability and control are involved.



SELF-SUFFICIENT : The U.S. Army Air Corps is experimenting with "motorised observation balloons." The craft is, in effect, a small "Blimp" which uses its engine to move from one location to another, and to assist in ascent and descent ; normally, it is moored to the ground and operates as a kite balloon.

likewise against an island kingdom which lives on its sea-borne imports. To that extent Britain must deplore the discovery of the art of flying.

On the other hand, ships at sea ought to be safer now that aircraft can reconnoitre and report. The raiding cruiser, in particular, will find in aircraft its worst enemy. In the Great War submarines would not venture to attack a convoy which was escorted by aircraft as well as by warships. This fact adds not a little to the prospects of Britain in a major war.

Hostile shore-based aircraft, however, may attack convoys when they come within range, and the convoy will be easier to spot than the single ship. Escort by fighters seems impracticable, and the anti-aircraft armament of destroyers (which do not make steady platforms) would probably be insufficient to drive off determined raiders. A double escort seems necessary, one against submarines and one against aircraft, and that would make heavy demands on our escort vessels. The moral is that we cannot have too many anti-aircraft cruisers.

Aircraft and the Fleet

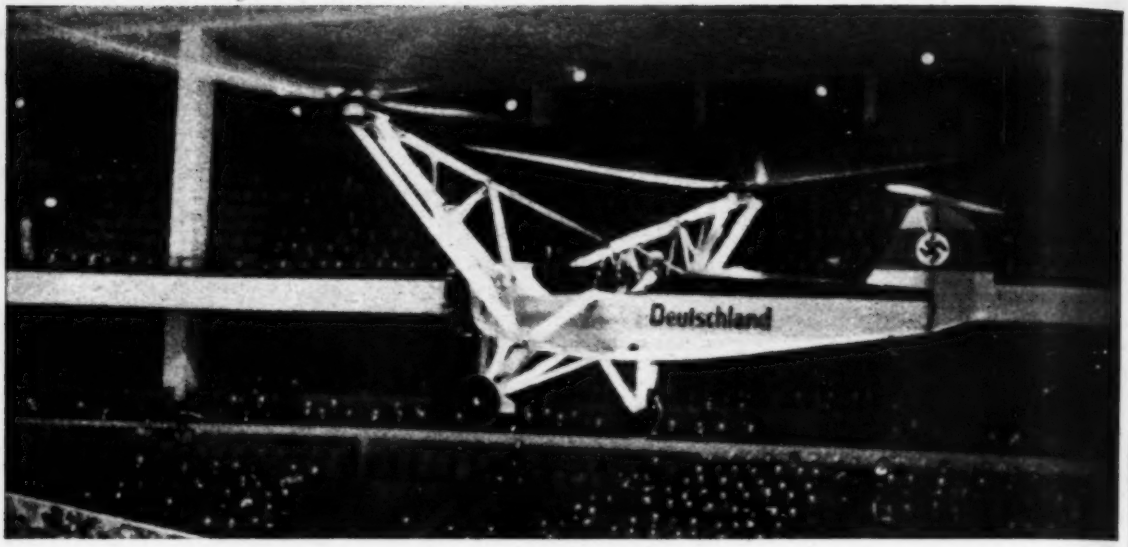
THE effect which aircraft can produce in a fleet action must depend very largely on the value which the carrier may prove to possess ; and to this question nobody seems prepared to give a definite answer. No one denies that the existing carriers are very vulnerable, and the design of the new ones now building has not been made public. But it does seem the general opinion that the daws will all try to peck out daws' eyes—in other words, that the fleet bombers on each side will make their first attacks on the enemy's carriers.

No writer seems to think that the fighters will be able to ensure the safety of their own mother ship, and there remains the question of whether the anti-aircraft guns will be able to do so. They may at least keep the precision bombers high up, and such experience as is available suggests that high bombing very rarely scores a hit on a ship. Dive-bombing will probably score hits, but one school holds that the bombs used by light bombers would not sink a ship, or even reduce its speed, while the damage could be as easily repaired as that caused by small shells.

As for the torpedo-planes, no one seems to have any fixed ideas as to whether they will prove potent instruments of destruction or will turn out to be suicide clubs. The point may only be settled by the next fleet action ; and therefore we all must hope that it will never be settled at all.

The present volume has little to say about catapult aircraft and their uses, but in a previous volume the writers spoke of them as the best spotters for the guns of their own ships. British naval gunnery through the ages has always been superior to that of any other nation, and if the catapult machines make it still more efficient, then the Navy will find that aircraft has added to, not detracted from, its fighting powers.

DIARY OF FORTHCOMING EVENTS—PAGE 394

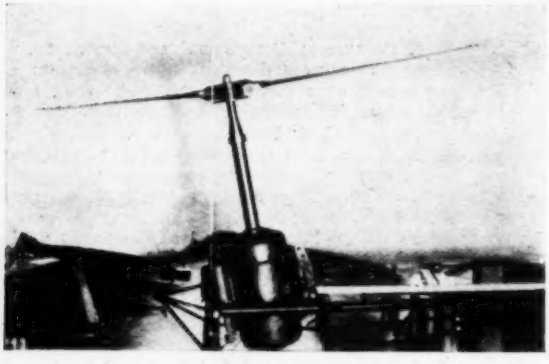


Fräulein Hanna Reitsch flying the F.W.61 inside the Deutschlandhalle in Berlin.

HELICOPTER PROGRESS

Professor H. Focke Explains the Reasons Which Caused Him to Select the Twin-Rotor Type, and Relates Some of the Results Obtained

AMONG the number of flights made by the Focke-Wulf F.W.61 helicopter in Germany since its first appearance last year, which included flights that established new world's records for this class of aircraft, none has carried more conviction than the flight made by Fräulein Hanna Reitsch *inside* the Deutschlandhalle in Berlin some weeks ago. Leonardo da Vinci foresaw the possibility of obtaining direct lift from a rotating airscrew, and for the last thirty years aeronautical engineers have known that it was possible to lift a flying machine into the air by means of propellers rotating in a horizontal plane. The great problem has always been that of controlling the aircraft once it had left the ground, and nearly every helicopter produced until the last few years has failed on this very question of controllability. The little German lady pilot proved to the world that the problem has been solved.



Model of three-bladed rotor driven by 3 h.p. electric motor for tests in wind tunnel.

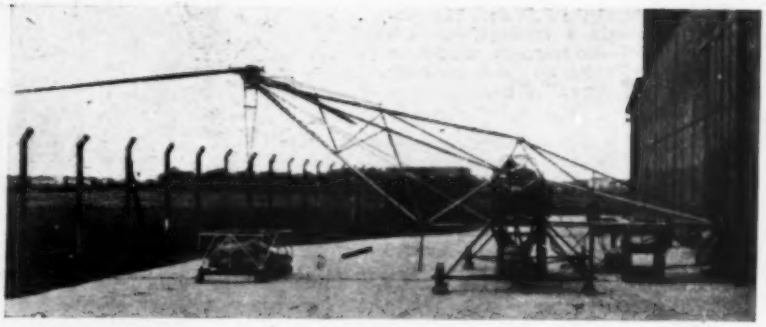
Petrol-driven model (0.7 h.p.) in free flight.

Understandable Reticence

In view of the time and money spent on its development, it is hardly surprising if Professor Focke has refrained from disclosing important mechanical details of the F.W.61. However, in a recent issue of the German technical journal, *Luftwissen*, he has published an article in which he describes his reasons for choosing among the several possible arrangements the side-by-side twin-rotor, gives an account of the development work which ultimately resulted in the F.W.61, and discloses some, although by no means all, of the features of this extremely interesting machine. Following is a summary of the article, illustrated by photographs kindly placed at *Flight's* disposal by Professor H. Focke. In this connection it might be mentioned that although Professor Focke is head of the Focke-Wulf company of Bremen, a firm which he founded many years ago with Professor Wulf, who lost his life in a crash on a Focke-Wulf *Ente* tail-first machine, the F.W.61 is a product of another company, Focke, Achgelis and Co. Herr Achgelis will not be a complete stranger to *Flight* readers, for a few years ago he startled British audiences by his inverted flying across aerodromes at a height of 30ft. or so on a Focke-Wulf machine.

Professor Focke pays a tribute to the late Señor de la Cierva, and points out that although the Autogiro is not a helicopter, it forms an intermediate step between the fixed-wing aeroplane and the direct-lift machine. He also expresses his indebtedness to the British aerodynamicists Glauert and Lock, whose theoretical work on autorotation served as a basis for his own calculations in connection with driven as distinct from autorotating rotors.

When he began his work in 1932, the following official



Test rig for single rotor, including an electric motor for the drive. Lift and power required at different speeds were measured simultaneously.

or unofficial helicopter records were in force: distance 1 km; duration about 10 mins.; altitude 18 m. These figures were not very encouraging, and Professor Focke realised that what he had to do was to produce an aircraft worthy of the name, and in order to do this he had to take into account and benefit by all the accumulated experience of those experimenters who had preceded him.

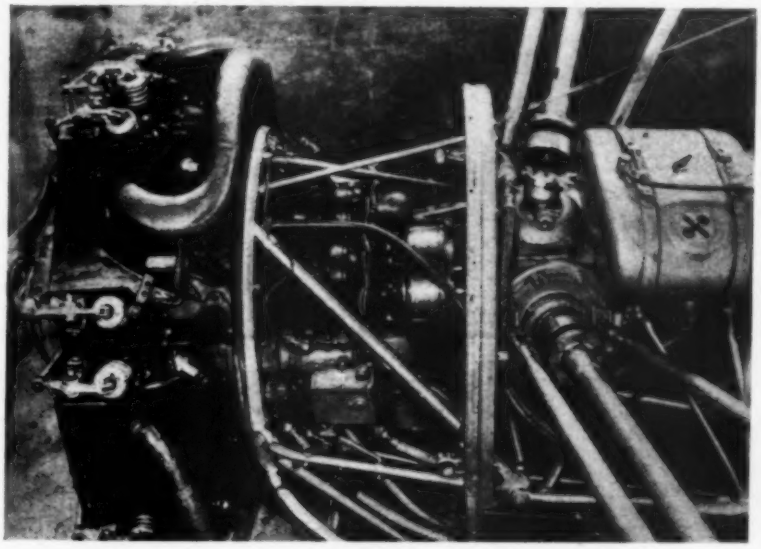
Professor Focke set up, in order of their importance, the following desiderata: Ability to land safely after engine failure; that meant incidence control of the rotor blades. Stability and controllability. General reliability. Simplicity of piloting. As good performance as possible. And last, but not least, the type of construction and general design to be such that people accustomed to ordinary aeroplane manufacture could build the machine.

The design of the rotor blades presented no particularly difficult problems. The three-bladed type was chosen for its efficiency, and its lift was ascertained by means of a model driven by a 3 h.p. electric motor. This model was tested in a wind tunnel, and the forces measured both in the driven condition and when autorotating. Great care had to be taken in making the measurements, particularly on account of the pronounced "ground influence."

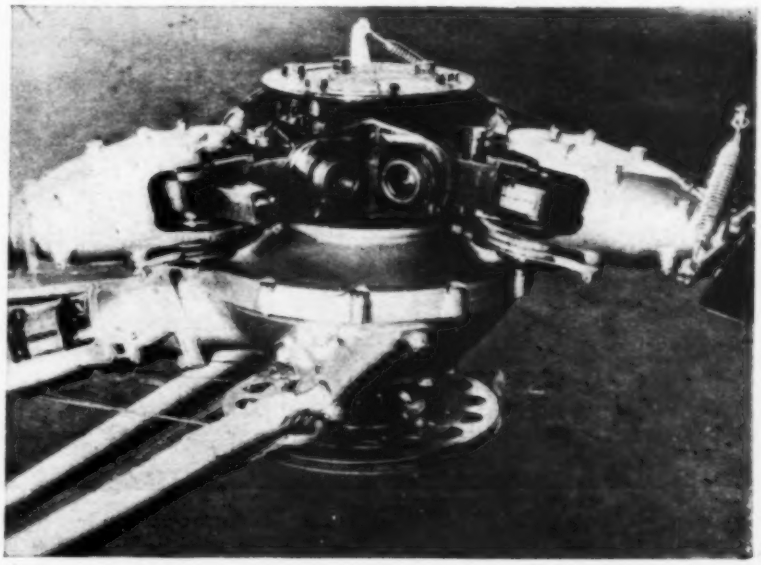
Torque

One of the fundamental problems which actually determines the general design is that of taking care of the torque-reaction from the rotor, which may reach considerable magnitudes. After examining all the rotor arrangements possible, Professor Focke decided upon the side-by-side twin-rotor arrangement as being the most efficient (each rotor working in undisturbed air) and free from the trouble with vibration encountered when one rotor is above the other. The price paid, in the form of aircraft drag, arises, of course, from the outriggers which carry the rotors. By running the two rotors in opposite directions, the torque-reaction is taken care of completely. Another advantage is that the only parts of the aircraft which are in the down-wash from the rotors are the outriggers.

Direct as distinct from indirect control was chosen as being more in keeping with the helicopter ideal and effective during hovering flight. A great deal of time was spent in scheming out an arrangement of control which would not only be natural for the pilot, but which would enable him to change instantly from direct lift to autorotation in case of engine failure. The only control surfaces of orthodox aircraft type are a fin and rudder, and a tailplane with adjustable incidence for trimming purposes. Professor Focke admits that the mathematical calculations connected with stability and control "reached terrifying proportions," but their justification came when, on its very first free flight, the machine reached a height of 400 metres (1,300ft.) and made a three-point landing. What made the procedure even more prolonged was the fact that repeatedly problems cropped up which would not be solved mathematically until certain test data had been obtained. How-



160 h.p. Siemens Sh 14a engine, with clutch and transmission.

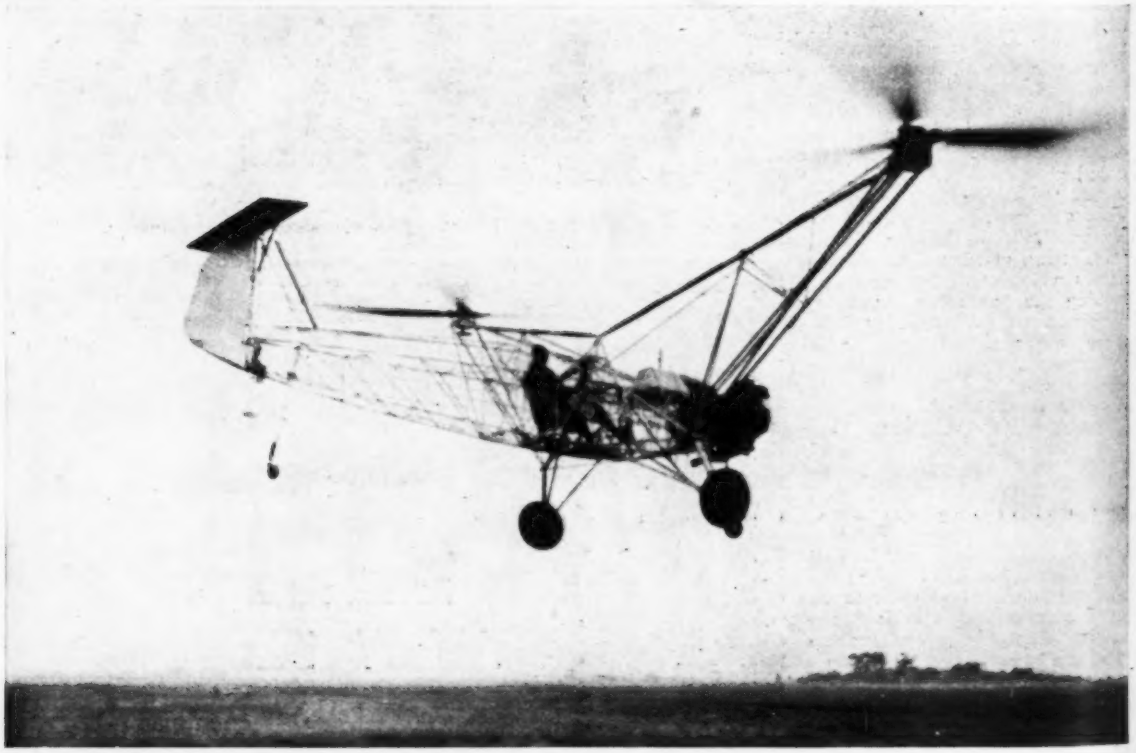


Rotor head with blade hinges and incidence control.

(Below) Nose of the F.W.61. The propeller is merely a cooling fan. The three-wheeled undercarriage should be noted. On the right is seen an early "tethered" flight.

ever, calculations and wind tunnel tests went on side by side, and finally the actual full-scale tests could be begun. Beforehand, however, a scale model was flown, fitted with a 0.7 h.p. petrol engine. This model is shown in one of our illustrations. Professor Focke dryly states in his article that "it goes without saying that the model was in bits more often than it was whole," but it provided valuable data, and by November, 1934, it had reached the height of 18 m. which was the altitude record of full-size helicopters at that time.

With the rotor characteristics determined there were still a number of mechanical problems to be tackled, and the guiding principle was established that the transmission, rotor heads, incidence control, and so forth should be treated exactly as a new aero engine in course of development. The Brandenburgischen Motorenwerke were given the task of developing the transmission and modifying the Siemens Sh 14a engine. First a single outrigger and rotor were built and tested in the manner shown in one of the photographs. Power in that case was supplied by an electric motor, so that both lift and power required could



An historical moment: The F.W.61 makes its first free flight, piloted by Ing. Rohlfs, on June 26, 1936. The fuselage had not yet been covered. Lateral and fore-and-aft control is by tilting the rotor heads.

be accurately measured. After preliminary tests a 50-hour run was made; the mechanism was dismantled, examined and reassembled, and another run of ten hours was made to see that all was still in order.

From the fact that there is an airscrew on the Siemens engine many have thought that this serves for propulsion. That is not so, and the airscrew is merely a cooling fan, although obviously it must exert a certain amount of thrust.

When finally the complete machine was assembled, the first flights were made with it "tethered." It was found that in this way a great deal of information could be obtained without running any risk of serious damage, the machine being "afloat," and subject to control, but too close to the ground to sustain breakages in bumpy "landings."

The first free flight was made by the Focke-Wulf test pilot Rohlfs on June 26, 1936, and by the time the tests had gone on for another year the machine was able to "collect" all the world's helicopter records. The German Air Ministry took delivery of the first F.W.61 in June, 1937, and of the second in October.

With what one may term the mechanical and control problems successfully solved, fundamentally at any rate, there remains the question of efficiency, which is another word for performance, in military applications at least. *Flight* has always held the view that it is unfair to compare a gyroplane or helicopter with the aeroplane, and that little useful purpose is served by so doing. These types of aircraft are capable of things quite outside the scope of the aeroplane, and obviously in the future there will be room for all three classes. It is, however, useful to compare the rotating-wing types with the aeroplane in order to obtain an idea of the excess of power required by the former. If that excess is too great, the price paid for the ability to fly slowly, hover, land with no run, rise without run and so forth may be too high. The experiments and calculations of Professor Focke show that fortunately this is not the case. By incorporating such refinements in design as are obviously possible, he comes to the conclusion that of two comparable types, the gyroplane need not be more than about ten per cent. inferior to the aeroplane in top speed, and that the pure helicopter is superior to the type in which the rotor is wind-milling, even after allowing for ten per cent. for cooling of the engine.

When it comes to rate of climb, the position is very interesting indeed. Comparing the Focke-Wulf Stieglitz aeroplane (870 kg. weight) with the Cierva C.30 (815 kg.) and the F.W.61 helicopter as gyroplane and as pure helicopter (950 kg. in both cases), the rates of climb for the Stieglitz and helicopter are almost identical at 3.5 metres per second, and those of the C.30 and F.W.61 as a gyroplane also almost identical but very inferior at 1.5 and 1.3 metres per second respectively.

The R.Ae.S. Garden Party

AN event which grows annually in size, scope and importance is the Royal Aeronautical Society's Garden Party, which, held in May each year, may be said to signalise the opening of the flying-meeting season.

This year's garden party is to be held on Sunday, May 8, the venue being, as usual, the eminently attractive and suitable Great West Aerodrome, lent by Mr. C. R. Fairey.

No details are yet available regarding the items in the flying display, but it can be anticipated that the civil and military machines demonstrated will be as representative as usual. There will again be a "static" show of accessories and equipment in the large hangar.

The party will begin at 2.30 p.m., and the flying display will last from 3 p.m. till 6 p.m.

Tickets (5s. each, including tea) are obtainable through members of the R.Ae.S., and the Society emphasises that early application is necessary; applications received after May 5 may have to be refused.

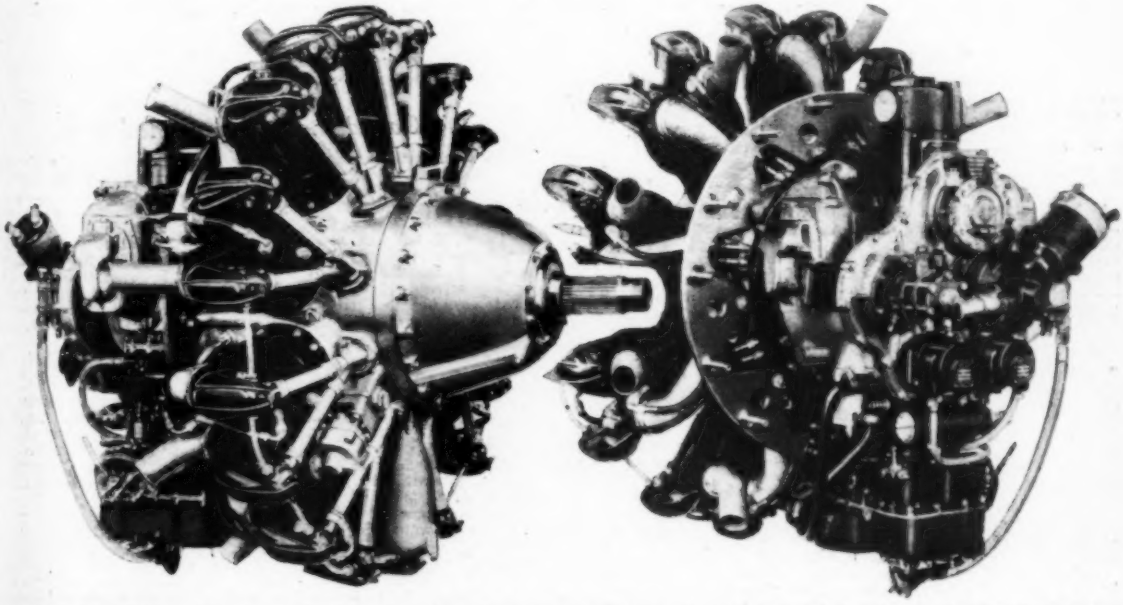
Back to Italy

EIGHT of the records for seaplanes formerly held by Italy and bettered in March this year by Germany, have now been won back again by Mario Stofpani and Goffredo Gorini flying a Cant Zappata 509, powered with three Fiat engines.

The records in question are for distances of 1,000 and 2,000 km., with loads of 2,000, 1,000, 500 kg., and without load. A circuit of Santa Marinelli—Naples (Vesuvius)—Monte Carlo back to Santa Marinelli was used, and speeds for four laps were 385.951, 393.631, 401.266 and 405.606 km./hr. These figures, in the same order, are approximately 241, 244, 249 and 252 m.p.h.

The average speed for the 2,000 km. course was 399.644 km./hr., and for the 1,000 km. course 403.424 km./hr. The German record on a Heinkel machine was 329 km./hr.

Series production of the Cant Z. 509 is now in progress at the Monfalcone (Trieste) works, and only Italian materials are used in its construction. Transoceanic services are in view. Three 18-cylinder Fiat A.80 R.C. 41 engines are fitted.



ALVIS ARRIVAL: Already completed and on test, the new medium supercharged, nine-cylinder Alvis engine measures only 41.5 inches in diameter. The capacity is 11.78 litres and the normal power output 375 h.p. at 3,000 r.p.m. and 5,000 feet. The mounting plate seen in the threequarter rear view is not part of the engine but an attachment used on the test beds.

SERVICE AVIATION

Royal Air Force and Official Announcements : Fleet Air Arm News : Military Aviation Abroad

SLEEVE-VALVES IN SERVICE : Vickers Vildebeest IV torpedo bombers (Bristol sleeve-valve Perseus VIII) approach the "convoy" during the recent Combined Exercises.

Chief of Naval Air Service

THE King has been pleased to approve the appointment of Vice-Admiral the Honourable Sir Alexander R. M. Ramsay, K.C.B., K.C.V.O., D.S.O., to be a Lord Commissioner of the Admiralty in succession to Rear-Admiral John H. D. Cunningham, C.B., M.V.O., to date about July, 1938.

It is intended shortly to alter the designation of the appointment in which Vice-Admiral Ramsay will succeed Rear-Admiral Cunningham from Assistant Chief of Naval Staff (Air) to Fifth Sea Lord and Chief of Naval Air Services.

Vice-Admiral Ramsay, who now holds the appointment of Commander-in-Chief, East Indies, is leaving Colombo for England on April 27, in anticipation of taking up his appointment at the Admiralty in July.

No. 1 Balloon Training Unit

THE training administration of No 1 Balloon Training Unit, Cardington, has been transferred from No. 24 (Training) Group, Training Command, to No. 30 (Balloon Barrage) Group, Fighter Command, with effect from April 1

Central Flying School

THE undermentioned reserve officers have recently been tested at the Central Flying School and are awarded the following categories:—

A.2.—Flt. Lt. G. F. K. Donaldson and F/O. R. E. Watts.
B.—Flt. Lt. E. G. Sharp and F/O. H. P. Hudson.

Observer Corps

A NEW Midland Area of the Observer Corps has been organised with headquarters at the R.A.F. Station at Grantham. The Commandant is Group Capt. V. O. Rees, O.B.E., formerly in command of the Northern Area. Headquarters of the latter have been moved from Hucknall station, Notts, to Catterick station, Yorks. Air Cdr. H. Le M. Brock, C.B., D.S.O., retired, has been appointed to headquarters of the corps at Stanmore as Deputy Commandant.

Period of Oversea Tours

THE Air Council have had under consideration the periods of oversea tours of officers and airmen with a view to making such reduction in the normal period of five years as may be practicable.

Subject to the requirements of the service, they have decided that in due course the normal period shall be reduced to three years, excluding the time allowed for necessary travel, except for Iraq and Aden, where the tour will normally be for two years only. So far as possible, officers and airmen will be posted direct from the United Kingdom to their oversea station and will return to the United Kingdom on the termination of their tour. The tours of duty with the Fleet Air Arm will remain as at present.

It will necessarily be some years before the new policy can be brought fully into operation and it will not be possible to give the full benefit of the reduction in the tour to officers and airmen at present serving overseas. Postings during the next and ensuing trooping seasons will, however, be so arranged as to effect such shortening as may be practicable.

Transfer of Officers to the Reserve

THE undermentioned short-service officers become due in October and November for transfer to the reserve:—

General Duties Branch

Flt. Lts. William John Howard Ekins and Anthony Delves Isemonger.

Medical Branch

Flt. Lts. Robert Alexander Cumming, M.B., Ch.B., and Francis Ivan Gershom Tweedie, M.R.C.S., L.R.C.P., M.B., B.Ch.

Foreign Officers Attached

CAPT. HAROLD NORMAN and Lt. Halfden Hansen, of the Royal Norwegian Air Force, have been attached to the Central Flying School, Upavon, from March 30 until completion of their course.

Lt. Kriangkrai Inkavanij, of the Siamese Air Force, has been attached to the Civil Flying School at White Waltham from April 4 until completion of the course.

Cdr. G. H. A. Wendelbo and Cdr. E. Manshaus, of the Royal Norwegian Navy Air Service, have been attached to the C.F.S., Upavon, from April 8, until the completion of their course.

A Canadian Armaments Industry

THE Canadian Government is attempting to create a national armaments industry, with particular emphasis on the manufacture of aircraft and small arms, by the establishment of branch factories of American aeroplane firms, or by the acquisition of licences, as, for example, that for the Grumman Hunter through the Canadian Car and Foundry Co. The establishment of a state armaments factory is not considered possible owing to the high production costs of such a scheme, and it is intended so far as possible to copy the British shadow factory system. During 1937 about 700 different factories were inspected by government authorities with a view to their incorporation in the new shadow system.

Flying Accidents

THE Air Ministry regrets to announce the following accidents:—A.P/O. Robert Brock La Pointe (pilot) lost his life and A.P/O. James Ronald Vincent was dangerously injured in an accident which occurred at Hullavington on April 7 to an aircraft of No. 9 Flying Training School, Hullavington, Stanton St. Quinton, Wiltshire. A.P/O. Vincent died the same day in the Cottage Hospital at Malmesbury.

With reference to the disappearance on April 4 of an aircraft of No. 100 (Bomber) Squadron, Seletar, Straits Settlements, as extensive search has failed to find the aircraft and its occupants, it must now be accepted that the following airmen lost their lives on that date: Sergt. William Douglas MacMillian Roberts (pilot), A/C.1 Ernest John Beisly, and A/C.1 Malcolm Renfrew Hunter.

Sgt. Walter Bateman lost his life in an accident which occurred at Abingdon on April 13, to an aircraft of No. 207 (B.) Sqn., Worthy Down. Sgt. Bateman was the pilot. The other occupant, L.A/C. Robert McPhie, was not injured.

Royal Air Force Gazette

General Duties Branch

The following F/O.s are granted the acting rank of Flt. Lt. on the dates stated:—P. D. Holder, F. S. Stapleton (March 3); H. M. Pinfold, G. E. Harrison, D. C. R. Macdonald (March 14); V. C. Wood (March 26).

Flt. Lt. M. Dawnay is placed on the half-pay list, Scale B, on January 7, and from March 29 to 31.

Royal Air Force Reserve

Medical Branch

Flt. Lt. H. R. Cline, M.B., B.Ch., relinquishes his commission on completion of service (March 31).

Royal Air Force Volunteer Reserve

General Duties Branch

D. F. McIntyre, A.F.C., is granted a commission as Squadron Leader with effect from April 12 and with seniority of September 2, 1936.

Auxiliary Air Force

General Duties Branch

No. 603 (CITY OF EDINBURGH) (B.) SQN.—Flt. Lt. E. H. Stevens is promoted to the rank of Sqn. Ldr. and appointed to the command of the Squadron (April 1).

General List

Sqn. Ldr. Lord George Nigel Douglas-Hamilton is appointed to the General List in the rank of Wing Commander on relinquishing command of No. 603 (City of Edinburgh) (B.) Sqn. (April 1); Sqn. Ldr. D. F. McIntyre, A.F.C., relinquishes his commission on appointment to a commission in the Royal Air Force Volunteer Reserve (April 12).

Royal Air Force Appointments

General Duties Branch

Air Commodores.—A. C. Wright, A.F.C., H.Q., No. 1 (B.) Group, Abingdon; for duty as Senior Air Staff Officer, 1.4.38. A. G. R. Garrod, O.B.E., M.C., D.F.C., to Directorate of Equipment, Air Ministry; on appointment as Director of Equipment, 31.3.38.

Squadron Leaders.—A. F. James, to No. 6 F.T.S., Netheravon; for Administrative duties, 28.3.38. J. S. Dewar, to R.A.F. Station, Thorney Island; for Administrative duties, 28.3.38. M. Lowe, to H.Q., R.A.F., Iraq, Dhibban; for Air Staff (Organisation) duties, 29.3.8. H. M. Pearson, to No. 54 (F.) Sqn., Hornchurch; to command, 28.3.38.

Flight Lieutenants.—A./Sqn. Ldr. K. R. Coates, to H.Q., R.A.F., Iraq, Dhibban; for duty as Liaison Officer, Persian Gulf, 29.3.38. J. W. A. Hunnard, to No. 6 F.T.S., Netheravon, 22.3.38. T. G. L. Gale, to No. 607 (County of Durham) (F.) Sqn., Usworth, 24.3.38. L. C. Slee, to H.Q., R.A.F., Aden, 26.3.38. A. McD. Bowman, to No. 28 (A.C.) Sqn., Ambala, India, 26.3.38.

Equipment Branch

Wing Commander.—R. F. Osborne, to H.Q., Training Command, Market Drayton; for Equipment Staff duties, 29.3.38.

Flight Lieutenants.—A. W. Rule, to H.Q., R.A.F., Middle East, Cairo, Egypt, 29.3.38. B. G. Pool, to H.Q., R.A.F., Iraq, Dhibban, 29.3.38. E. G. Northway, M.B.E., to No. 203 (G.R.) Sqn., Basrah, Iraq, 29.3.38.

Accountant Branch

Wing Commander.—W. R. Westcombe, to H.Q., R.A.F. Mediterranean, Malta; for duty as Command Accountant, 29.3.38.

Squadron Leader.—D. J. Sherlock, to R.A.F. Station, Kalafrana, Malta; for Accountant duties, 29.3.38.

Flight Lieutenant.—E. A. Biddle, to R.A.F. Station, Amman, Transjordan, 9.3.38.

Medical Branch

Squadron Leader.—R. G. Freeman, to Central Medical Establishment, London; for duty as Medical Officer, 28.3.38.

Chaplains Branch

Rev. R. W. Briscoe, to No. 4 F.T.S., Abu Sueir, Egypt; for duty as Chaplain (C. of E.), 29.3.38.

Owing to the greatly increased length of these lists as a result of R.A.F. expansion, ranks are confined to those of Flight Lieutenant and above.

FOREIGN SERVICE NEWS

U.S. Dive Bombers

IT was principally in America that the modern technique of dive-bombing was evolved. To-day, when several air arms are openly questioning the practicability of the steep diving attack the U.S. Navy is taking into service large batches of dive-bombing machines to augment the squadrons of Vought and Great Lakes biplanes already used for the work. The most highly developed biplane is the Curtiss SBC-3, now known as the Helldiver, though it bears little resemblance to the old Wasp-engined biplanes of film fame. Later monoplane types are the Northrop BT-2, which resembles the machines used by the Army Air Corps for attack work (and, incidentally, Bristol's flying test bed for the Hercules), and the experimental mid-wing Brewster. These last types are counterparts of the Blackburn Skua and will presumably take advantage of the reversible-pitch airscrews developed by the Curtiss and Hamilton Standard concerns to retard their speed in a dive. The standard bomb load is either a 500 lb. or a 1,000 lb. bomb. An attack by a force of such machines, it is argued, should be effective even against heavily armoured capital ships

The Four Norsemen

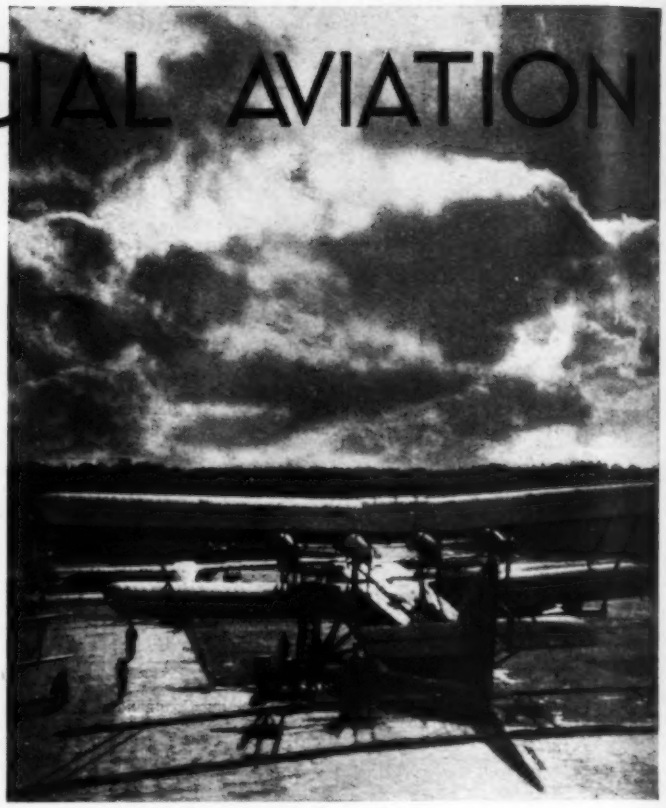
FOUR Norduyn Norsemen high-wing monoplanes have been ordered by the Royal Canadian Air Force for use as "flying classrooms." Each will accommodate from six to eight instructors and students and will be used to teach bombing, map reading, navigation, sketching, radio and artillery spotting. Gun mountings will be included. With the 525 h.p. Wasp engine the top speed will be about 170 m.p.h.

Parasol Prototype

ONE of the most stimulating single-seater fighter designs to be realised in recent times is the Focke-Wulf Fw 159 parasol monoplane with inverted Junkers petrol engine. The undercarriage retracts into the fuselage and the wing is braced by a single main strut on each side. Details of performance and armament are withheld, but the machine ought to be good for at least 270 m.p.h. The Focke-Wulf concern has also introduced a new twin-engined general purpose monoplane (Blenheim category) likewise powered with the inverted Junkers.

AMPHIBIAN FIGHTER: Virtually the so-called "Convoy" fighter with amphibian gear, this machine is seen before being dismantled for shipment from America to Russia. If the wings are used as tanks a range of 6,000 miles is claimed to be possible. By interchanging wing panels and power units the machine can be used as a trainer, for observation, or as a light bomber. Quantity production in Russia is probable.

COMMERCIAL AVIATION



THE WEEK AT CROYDON

Easter Travel : Beyond Land's End : The Booking Ban : Speed and Schedules : No Easter Egg

DRAWING a bow at a venture, for I write in the middle of the holiday period, I should say this ought to prove a record Easter for air travel. A tremendous number of extra services are scheduled to Paris by Imperials, Air France and British Airways, all of which seem to be fully booked up in advance. Swissair, as usual, are full up on all services, and K.L.M. have been running to capacity, for the bulb fields in Holland are at their best just now. Le Touquet, as usual, is the most-favoured Easter resort, and Olley Air Service, Imperials and others just keep on darting monotonously to and fro.

The Penzance-Scilly Isles service run by Olley Air Service was working overtime at Easter, over 500 passengers having been booked in advance. Two Dragons have been making 2½ trips per hour all day long. The Railway Clearing House ban has not been lifted here. Incidentally, the railway chiefs, who have been writing about the booking ban in the correspondence columns of one of the leading dailies, appear to have come out of it rather badly. One of their points was that the agents only existed with the help of the railways, a fact which was disproved. An interesting example of "method" cropped up, too. An independent operator, about to put a service on from A to B, was asked by the rail people not to do so, lack of useful traffic being given as the reason. The company informed the railways that they believed there *was* traffic for one service each way daily. Within a day or two Railway Air Services put three services each way daily on the very route which they had insisted would not bear one service a day.

Mind you, nobody blames Railway Air Services, whose efficiency and splendid record we all admire. One can be sorry for R.A.S. just as one would be for a highly efficient bird which found itself compelled to fly only at the orders of some giant sloth hanging head down from a bough, with its face buried in rank grasses.

On Wednesday of last week Sir Kynaston Studd, with Lady Studd, flew to Switzerland, thus celebrating his golden jubilee of travel and connection with travel. For many years now Sir Kynaston has travelled twice a year to Switzerland, and this time he will celebrate his 80th birthday there.

Capt. E. B. Fielden, of British Airways, had a strong tail wind all the way from Stockholm to Croydon one day last week and was obliged to loiter with the Electra, otherwise he would have been badly ahead of schedule. As things were, he managed, not without difficulty, to arrive at Croydon exactly on time. At one time the strength of the wind behind him was almost 90 m.p.h. at 8,000ft. There are commercial aeroplanes in use to-day which would stop absolutely still in one place if confronted with such a wind, which is the best reason I know for using fast aircraft.

On Easter Sunday Cdr. van Weywrother, of K.L.M., arrived at Croydon after a record flight from Alexandria, taking only 12½ hours to do what is normally scheduled at 17½. He was not trying to break records, but just doing what any ship's captain would do if possible—make up for delays and arrive on time. He had nine passengers for London on board, three from Rangoon, two from Allahabad, one each from Jodhpur and Karachi, and two from Alexandria. Those who still think that it is tiring to travel fast in a modern machine should have seen those passengers on arrival. They were right on top of their form and glad to be home in time for Easter.

With the idea that one should have something new for Easter to surprise the egg-faced holiday travellers, Imperials rather hoped that somebody might remember that the Ensign is a trifle overdue for delivery. It did not arrive, of course, and it was therefore scarcely kind of the Rt. Hon. Winston Churchill (hat back to front, eagle's feather in prow) to have enquired with suspicious innocence whether poor old *Scylla* was one of the new machines he had heard so much about. A. VIATOR.

Paris Traffic

IMPERIAL AIRWAYS will have to look to their laurels since it appears that Air France are now carrying more passengers between Croydon and Le Bourget than any other operating company. Apparently their lead was taken with the introduction of the Bloch 220 on March 27; this machine not only provides a 75-minute schedule, but also a 60 per cent. increase in the available accommodation—of which there was previously something of a shortage in the case of the Wibaults.

The actual figures from the period between March 27 and April 10 were: Air France, 558 out and 627 home; Imperial Airways, 466 in each direction; and British Airways, 369 out and 330 home. During Easter no fewer than 70 passengers were turned away by Air France on the Thursday before the holiday.

Which seems to confirm the general opinion that speed is the principal advantage which air transport has to offer. Things may change again when Imperials have their A.W. Ensigns in service.

COMMERCIAL AVIATION (CONTINUED)

A.B.A.'s First Ju.86

ON April 1, Swedish A.B. Aerotransport took over their new Junkers Ju.86 which has been specially fitted up for night mail work. With the customary standardisation of power units A.B.A. have had the machine fitted with Pratt and Whitney Hornets of 715 h.p. each, and with these engines the machine has a maximum speed of 217 m.p.h. The Ju.86 will fly on six nights a week on the Stockholm-Malmo-Copenhagen-Hanover run, carrying a maximum load of about 3,300 lb.

Isle of Wight Ferry

ON and after May 23 the P.S.I.O.W.A. Portsmouth-Ryde service will be run on a half-hourly basis, with six daily services between Bournemouth and Ryde in conjunction with Railway Air Services, and seven trips between Southampton and Ryde.

Loud speakers have been installed at Ryde and, during the busy periods, passengers will tear off a "place number" on arrival, and this number will be called out over the speakers when the machine is ready to start. This will prevent the necessity for queueing.

Glasgow Direct

IN a paragraph in last week's issue it was explained that between May 2 and May 21 Railway Air Services would operate a direct service from London to Glasgow. We omitted to add that thereafter it will still be possible to make the through trip, passengers changing from the Belfast machine at Liverpool on the morning service. The inclusive time for the run between Croydon and Renfrew will be 3 hr. 20 min. Incidentally, the two Belfast services, to be operated daily after May 22, will call at Birmingham and Manchester, Stoke, as before, being an "on demand" stop.

Selling Aviation

THE people in aviation appear to be developing the excellent habit of telling the world in general all about it in the most attractive way. Not long ago we received a booklet from Highland Airways—shortly to become a part of Scottish Airways—and now the owners of the Rand Airport, Germiston, South Africa, have sent us a copy of their official Year Book.

This is not only an attractive pamphlet setting forth the particular features of the airport and of the services which use it, but is also a useful guide for any pilots and others who are visiting Johannesburg. There is a large plan of the landing area and buildings, with all the necessary information about the facilities obtainable and the surrounding landmarks. Nowadays, with the Imperial Airways' boats flying to Durban, where the mail and passengers are taken over by South African Airways, the Rand Airport sees the old Atalantas no more, and it is pleasant to find that a page has been devoted to the good work done by Imperials since January, 1932, when the first D.H. Hercules came through on the regular Imperial service.

The manager of the Airport is, incidentally, Capt. Roy Makepeace, M.M., who was appointed to the post in February, 1932.

Trans-Canadian Plans

ALTHOUGH a start has since been made with the operation of the Winnipeg-Vancouver section of the trans-Canada air service, the report of the first year's working of Trans-Canada Air Lines, which has just been issued, provides some interesting facts and figures.

The Vancouver-Seattle section of the service, for instance, was taken over from the original operators, Canadian Airways, as long ago as September 1 last year. At the time when the report was issued the staff numbered seventy-one. The five Lockheed Electras, which were ordered, have already been delivered, and the first of the ten Lockheed 14s should soon be in action.

Canadian National Railways, who hold all the issued shares of the concern, are attending to the commercial side of the operations, a fact which, as in the case of our own Railway Air Services, should certainly make for economy and for a reduction of overhead expenses.

Mr. S. J. Hungerford, the president, hopes that the complete service will be in operation this year. It will be remembered that the planned route is Moncton-Montreal-Ottawa-Toronto-North Bay-Kapuskasing-Wagaming-Winnipeg-Regina-Lethbridge-Vancouver, with branches from Lethbridge through Calgary to Edmonton, and from Vancouver to Seattle.

I.A.F. to Brussels

INTERNATIONAL AIR FREIGHT expect to start their service to Brussels on May 3, machines leaving Croydon at 6.45 a.m. and leaving Haren airport at 5.15 p.m. The Amsterdam service is now run twice daily, the Curtiss Condors leaving Croydon at 6.30 a.m. and 2 p.m.

I.A.F. have reduced the business of arranging for freight transport by air—which is their sole work—to the simplest possible form. Incidentally, the company has made arrangements for the travel agencies to carry heavy luggage which the passengers on normal air services are not usually able to take with them.

A.S.T. Additions

BY the end of next month the addition of a further thirty-seven acres to the landing area at Hamble should have been completed, and work on the construction of the new gymnasium is already well under way. This building will be only a few yards from the swimming-pool.

During last month three long-course pupils at A.S.T. completed their training and obtained posts with a well-known operating company, and the nine students and six staff fitters who recently took their G.E.'s examination have all passed. During the month Flt.-Lt. H. F. Jenkins, A.F.C., the chief instructor, was promoted to the rank of Squadron Leader in the R.A.F.

Batavia—Manila

AN agreement has been reached between K.N.I.L.M. and the American Government in the matter of the projected Batavia-Manila service, which is to be run in pool with Pan-American Airways, for whom, of course, Manila is to be considered as a terminal on their trans-Pacific service from San Francisco to Hong Kong. The new service will, therefore, link the Netherlands Indies and Australia with these points; previously it has been possible to reach Hong Kong by the Imperial Airways service from Penang.

Incidentally, the new aerodrome at Bali, which has been approved by the N.I. Government for all types, has been officially opened.

A Flying Test Model

A FLYING scale model of the CAMS Potez 161—the six-engined flying boat ordered by Air France for the North Atlantic—has been built at Sartrouville by the Northern group of the French National Aircraft Constructors. The engines of the flying model are 60 h.p. Trains, taking the place of the six Hispano 12 Ys to be used in the full-sized prototype.

Meanwhile, work has actually started on the construction of the forty-tonner. The military authorities in France are at present taking a great interest in heavy transport machines, and are studying the possibilities for these purposes of the Atlantic flying boats of Air France Transatlantique—the CAMS Potez 161, the Latécoère 631 (*Lieutenant de Vaisseau Paris*) and the Sud-Est 200.

THE AIRLINE OUTLOOK

Special Issue of "Flight" next Thursday

NUMEROUS important aspects of airline operation will be reviewed in FLIGHT next week. The issue is a special one, the COMMERCIAL AIRCRAFT and AIRLINES NUMBER.

Sections will be devoted to British airliners and other operating equipment available, while the activities of British airline companies will be reviewed.

A large loose-inset map, in photogravure, specially prepared by FLIGHT artists, will portray the present layout of the world's air routes, including a larger-scale map of the European routes.

In addition, authoritative articles will deal with such subjects as the Economics of Air Transport, Trends in Airliner Design, and Legal Aspects.

NEXT THURSDAY FLIGHT **APRIL 28**

THE FOUR WINDS

ITEMS OF INTEREST FROM ALL QUARTERS

MISS ELIZABETH LION, a French pilot, flew the 2,000 miles from Paris to Tunis and back in 18 hr. 10 min.

Trans-Canada Airlines have ordered an additional six Lockheed 14 machines to be used on their complete Vancouver-Winnipeg service when it is inaugurated next autumn.

A new inverted six-cylinder Fairchild Ranger engine—the 6-410B-1—has been given type approval for a rating of 165 h.p. at 2,400 r.p.m. and 125 h.p. at 2,250 r.p.m. It weighs 350 lb.

In Egypt, on April 12, Sqn. Ldr. Mole was towed to a height of 15,400ft. in a glider and made 147 successive loops during the descent. This is a world's "record," the previous greatest number being 125.

The organisers of the Paris Aero Show (November 18 to December 4) plead for early application for stand space. Enquiries should be addressed to M. le Commissaire Général, 4, Rue Galilée, Paris 16e.

On April 25, at the Scala Theatre, London, "A Grand Night of Magic and Variety" will take place in aid of the funds of the Air Ministry Social Service Association. Lord Swinton will make an appeal. Applications for seats (price 1s.) must be sent to Mr. Walter Kemp, Room 751, Alexandra House, Kingsway, London, W.C.2.

A. Lewis MacClain, chief test pilot of Pratt and Whitney Aircraft, is now in Europe to confer with European officials on the installation and operation of P. and W. engines. As co-author of a paper on cowling and cooling of air-cooled engines and another on flight testing with an engine torque indicator he was in 1935 and 1937 awarded the Manly Memorial Medal by the Society of Automotive Engineers of America. In 1935 he was also awarded the Wright Brothers medal.

SKY SIGN: On the occasion of Field-Marshal Goering's presentation of the first German-Austria flag to an Austrian Squadron, Austrian Fiat C.R.32 fighters made a swastika in the sky over Wienerneustadt. Field - Marshal Goering is commander-in-chief of the German Air Force. In the foreground can be seen a Dornier D.O.17 fighter-bomber as fully described in an exclusive *Flight* article last week.

To-night, April 21, Prof. John E. Younger, Professor of Mechanical Engineering at the University of California, is to lecture before the R.Ae.S. on "High Altitude Flying, with particular reference to its engineering aspects, and recent developments in the United States."

Prof. Younger will discuss structural and mechanical questions, airflow regulation, atmospheric problems and the question of fuel supply. The lecture will be delivered at 6.30 p.m. at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. Admission is by tickets obtainable through members.

BREAKING NEW GROUND: The new Timm light transport which takes advantage of Handley Page slots and slotted flaps and does over 200 m.p.h. on a pair of Wright Whirlwinds. View and landing characteristics should be superior to those of the majority of commercial machines in the air to-day.

Three R.A.F. machines "bombed" the villages of Frindsbury Extra, Wainscott and Hoo in Kent during A.R.P. exercises; 200 volunteers took part.

Forty-year-old Romeo Vachon, veteran Canadian airman, has been awarded the McKee Trophy, Canada's most important aviation award, for his work in developing the commercial air services along the north shore of the St. Lawrence River.

Prince Bibesco, president of the F.A.I., has offered a cup to be competed for annually by sailplane pilots of all countries. It will be awarded for the fastest soaring flight to Bucharest from some specified place not less than 1,000 km. distant. Intermediate landings will be allowed, and all launches will be by aeroplane-tow to not more than 800 m.

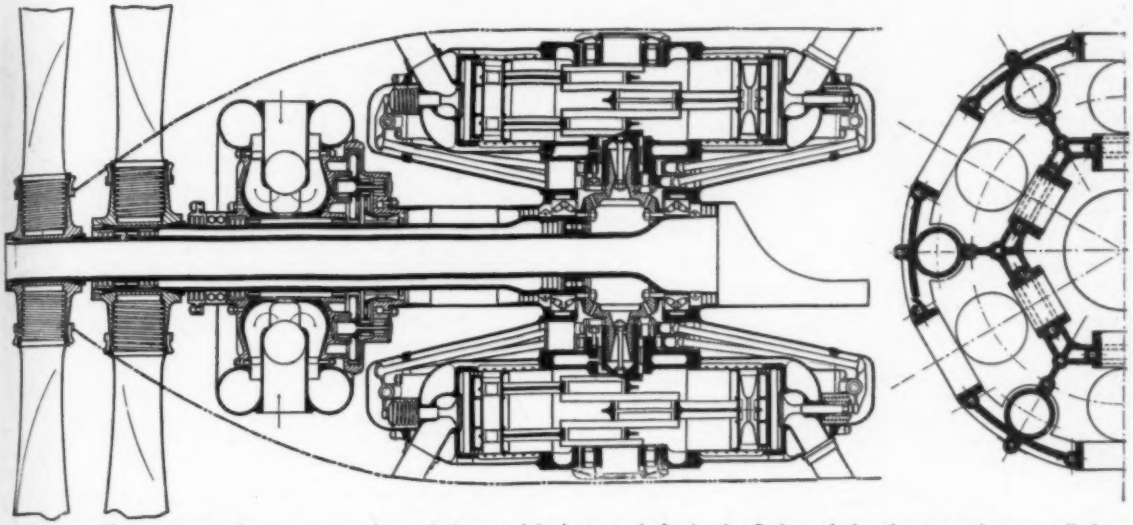
Twenty-five Years Ago

(From "Flight," April 19, 1913.)

"A well-organised Royal Flying Corps, using well-tried machines, will be a more effective arm in war than the exploitation of latest inventions. But, it is essential that the experimental type should be encouraged and pushed forward with all speed, and when one is dealing with experimental work of this kind it is impossible to consider cost in the same way that it is considered in respect to the purchase of an approved and established article."

A NOVEL FRENCH PROJECT

"Moteur-Canon : Reducteur : Inuerseur : Double-Helice"



Six two-cylinder power units are arranged round the coaxial airscrew shafts in the Gadoux design for a 900 h.p. 12-cylinder supercharged engine. It is liquid-cooled and intended for a small high-efficiency fighter with a shell-gun firing through the airscrew shafts.

WHAT at first glance appears to be one more particularly involved example of the unorthodox engine designs which appear with such regularity is actually a very ingenious plan for coupling up several small engines of normal design and arranging them in the most suitable form for installation in a small high-powered fighter with a shell-gun as part of its armament.

The fighter, envisaged in this case by our contemporary *Les Ailes*, would have a supercharged engine of over 1,000 h.p. output, driving concentric airscrews in opposite directions and having a shell-gun firing through the airscrew hub.

Advantages of this arrangement are, briefly, that the airscrews necessary to absorb the power can be considerably smaller in diameter than if one airscrew were used—this means, first, an increase in the efficiency of the airscrews considered individually and, secondly, a decrease in the height of undercarriage necessary to give the required ground clearance for the blades.

Torque Cancellation

Besides these important points there is the question of torque reaction, which has become something of a problem in single-engined machines of 1,000 or more horse-power, but which, in this case, is automatically cancelled out by the use of concentric airscrews rotating in opposite directions. Finally, the slipstream from a single airscrew takes a roughly spiral course about the fuselage, whereas the flow from concentric airscrews is undistorted and passes over the body of the machine normally, in effect improving its streamline.

The engine owes its conception to a well-known French designer, M. Maurice Gadoux, who was chief engineer of Delaunay-Belleville, and for ten years assistant technical director of the Hispano-Suiza concern.

Six opposed two-cylinder units are grouped round the coaxial airscrew shafts in revolver chamber form, with its barrels parallel with and equidistant from the shafts.

Each separate unit has overhead valves with totally enclosed push-rods and rocker gear. To avoid offsetting the cylinders on the crankshafts one piston has a single connecting rod, while the other has two smaller ones placed either side of it and totalling the same weight as the single one.

The crankshafts of the six units fall radially round the airscrew shafts and each carries a bevel gear engaging, at the front, the bevel driving the rear airscrew or outer shaft, and, at the rear, the bevel for the front airscrew or inner shaft. Down the centre of this inner shaft, passing through both bevel gears and the two airscrew hubs, would be placed the shell-gun barrel.

Distributed Load

The bevel gears, besides providing the drive, also take the place of a reduction gear. As the total output of the engine comes, in effect, from six sources and the power from each source is divided between two airscrews, the load transmitted by any one gear tooth at any moment cannot be more than one-twelfth of the engine's total output. This splitting-up of torque is said to give very smooth running and it would appear that there is less chance of failure than in the case of, say, a spur-type gear where the whole power is being transmitted at any one moment by a single tooth.

Although well over 1,000 h.p. is visualised for single-engined fighters of the type in question, the first *moteur-canon G.C.*, as it is called, is designed to give 900 h.p. at 3,600 r.p.m. (75 h.p. per gear tooth).

The six units of 150 h.p. are ethylene-glycol-cooled and each cylinder has a bore and stroke of 160 mm. by 110 mm.—a total swept volume of 25.5 litres. A drive for a supercharger is taken from the airscrew shafts between engine and nose, and this, it is presumed, would have a first and second stage.

The length of each unit is 100 cm. and the diameter of the group 88 cm.

The Wasp as a Settler?

AUSTRALIA recently welcomed that enthusiastic young Dutch-American aero engineer, Mr. P. W. Shipper, who has arrived in the Commonwealth to become engine chief to the Commonwealth Aircraft Corporation Pty., Ltd., at Fishermen's Bend, Melbourne. Speaking of the Pratt and Whitney Wasp—a slightly modified version of which is to be built in Australia under his direction—he is reported to have said: "We are not going to stand still, but will make modifications here and there, and will probably transform the engine within three or four years. It will then be recognised as a real Australian engine of distinctly Australian type."

Height Computation

A SOMEWHAT erudite work has just been produced by the Meteorological Office in the form of *Professional Notes No.* 80, and published by H.M. Stationery Office. This paper, which is written by Mr. E. G. Bilham, B.Sc., describes a mechanical device which has been developed for the calculation of the "true" height of an aircraft from observations of pressure and temperature.

This instrument has been made in two forms, one for computations up to 24,000 feet, and another, in more elaborate style, for use in estimating the position of machines at still greater heights.

AMONG the BOOKS

A Mixed Bag, Technical, Fictional and General, Recently Published

Plain Fiction

"Solo," by Nicholas Bodington; 7s. 6d., Victor Gollancz.

TREATED as quite effectively written pieces of fiction, the three flying stories which make up this book are praiseworthy, but the author fails to convince us that he really understands or has experienced the sort of serious flying with which he deals. To the pilot or the person who is intimately connected with flying, *Solo* lacks conviction and one can think of at least two American books on similar lines in which the job of providing the true flying atmosphere has been done a great deal better.

The author, in one case, takes his central figure on a solo flight across the Atlantic and back and, though the pilot has been provided with radio equipment, he does not appear to make real use of it other than in the transmission of somewhat melodramatic messages of no great import. Direction-finding is not even mentioned, and at Paris this lone flyer was expected to refuel his machine in the air single-handed. On his way over he watches the shadow of his machine on the mist below and calculates therefrom that he must have a strong following wind.

Perhaps we have been caused to expect a little too much by the nature of the "blurb" on the dust cover, in which Mr. Bodington is claimed to have written "the most remarkable book of fiction about flying since *L'Equipage*." The lay reader will undoubtedly take more kindly to it.

"Banners Yellow," by J. E. Gurdon. George Newnes, Ltd.; 7s. 6d.

A YARN of the Arctic wastes, introducing two brothers, a blind man living alone in the wilderness beneath an overturned boat, his Grim Secret, and an amphibian. Mr. Gurdon has ample aeronautical knowledge and the command of sensitive descriptive writing.

Meteorological Survey

"The Climate of the British Isles," by E. G. Bilham; 21s. Macmillan and Co., Ltd.

JUST recently there has been something of a spate of good books dealing with meteorology and with the more advanced aspects of air navigation. Mr. Bilham's book is not intended necessarily for air navigators, but for those students of the subject of meteorology who require a really comprehensive summary of accumulated information concerning the weather in this part of the world. In fact, it is probable that the textbook will, as the author tends to suggest in his preface, be of more value to the vast number of people for whom to-morrow's weather is a matter of tremendous financial or other interest.

The opening chapters themselves form something in the nature of an elementary textbook in meteorology, dealing as they do with the general "structure of weather," with the factors which control climatic variations and with the different characteristic types of weather. The author goes on to deal exhaustively with wind variation and averages—it is interesting to discover that the maximum recorded speed in this country was 111 m.p.h. at Scilly in 1929—with rainfall fluctuations, with temperatures, humidity, storms and special conditions.

The whole volume covers well over three hundred pages, with more than a hundred illustrations and an almost equal number of tables—many of which provide extremely interesting comparisons which are probably not available elsewhere and certainly not without a strenuous search among official pamphlets.

Miscellaneous

"Flags of All Nations," price 1s. 6d. Brown, Son and Ferguson, Ltd., 52-58, Darnley Street, Glasgow.

A FOLDER which opens out in map style, this work shows 565 flags in colour. These include national flags, ensigns, Royal Yacht Club and pilot flags, and the new international code of signals.

The Air Annual of the British Empire, 1938. Sir Isaac Pitman and Sons, Ltd.; 21s. net

DESPITE the inevitable coagulations of facts and figures the compilers of this year's Air Annual have managed to paint a colourful picture of Empire aviation. Contributions include "The British Aircraft Industry, 1936-37," by Mr. F. Handley Page—a masterly review of twelve months' progress. Technical subjects are treated by recognised authorities.

"Principles of Advertising for Engineers," by C. W. Hanson; 3s. 6d., "The Engineer," 28, Essex Street, Strand, London, W.C.2.

ALTHOUGH intended mainly to assist mechanical engineering firms, much of the contents of this very sound little book should be found of value to those charged with the duty of advertising the wares of aircraft, aero engine and ancillary firms. There is sound advice on, among other things, making the best use of the space taken, on the preparation of lay-outs, and on pitfalls to avoid.

"'The Autocar' Guide for the 'L' Driver"; 1s. 2d. (including postage), Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

A REVISED edition of "'The Autocar' Guide for the 'L' Driver" has been published recently. In simple language and starting from "scratch," this book takes the aspiring motorist from the first lesson through reversing and night driving to the official driving test, and concludes with an explanation of licensing regulations and other useful information.

Royal Air Force Flying Training Manual, Part I—Landplanes. His Majesty's Stationery Office, London; 6s. net.

THE most critical and exacting student will find little to quarrel with in this truly excellent exposition of the elements of landplane operation. We can heartily recommend it as one of the finest instructional works we have ever seen. Apart from the more prosaic sections on the theory of flight airmanship on the ground and basic flying there is a particularly interesting chapter on formation flying as practised by the Service. The material on engines is also extremely valuable and right up to date.

"French War Birds," by "Vigilant"; 8s. 6d., John Hamilton.

INTIMATE glimpses of the great French war pilots in action and off duty go to make up this most absorbing and illuminating gallery of pen portraits. There is little or none of the "Jean Blanc was born at Hamville one frosty morning in June . . . "; each portrait, impressionistically treated, is done in broad, sweeping strokes, which, nevertheless, offer a revealing cross-section of a man's character. To select for quotation one combat description or one leave-time episode would be to subject oneself to an *embarrasse de richesse*.

Still Higher

THE Silver C certificate, to obtain which soaring flights of five hours' duration, 50 kilometres distance and 1,000 metres climb must be made, will no longer be the highest award a sailplane pilot can earn. The International Committee for the Study of Motorless Flight (Istus) has now instituted a gold badge for pilots who have soared a distance of 300 km. (186 miles) and climbed 3,000 metres (9,843ft.) above the start. For the altitude test a considerable experience of blind flying in cumulus clouds will be almost essential.

The Commission has also decided to award annually an "Istus Ring" for the most valuable contribution, in flying, technical, or scientific work, to the science of soaring flight during each calendar year.

Representation in India

WITH the general object of facilitating and furthering aviation in India, Mr. R. Vaughan-Fowler, through the company of which he is a director, Indian Aviation Development Co., Ltd., has formed an "Aviation Association."

The organisation, it is intended, shall watch the interests of various groups which in this country mostly have associations of their own but which in India are not numerically strong enough to be thus represented.

The groups will include commercial pilots, ground engineers, aerodrome, met. and radio officers and staffs, aerodrome owners, private pilots and enthusiastic members of the public.

The Indian Aviation Development Co., Ltd., is in Maneckji, Wadia Building, 125, Esplanade Road, Bombay.

MAJOR and MINOR DEVELOPMENTS

Cirrus Engines at Home : Test Methods : Some Foreign Installations

EXTENSIONS to premises are always a good sign, indicative of plenty of work on hand and further prospects ahead. Cirrus engines have outgrown the premises allotted to them on arrival at Brough from Croydon, and scaffolding and piles of builders' material tell their own story.

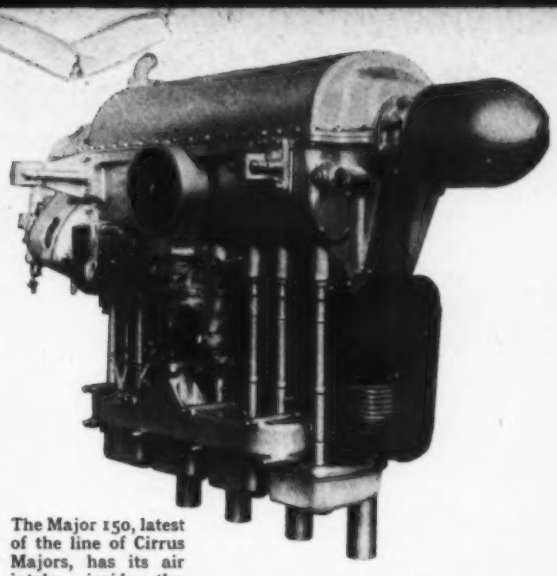
It is now something over two years since Cirrus became part of Blackburn Aircraft. During that time the Cirrus Minor in its latest form has been developed and a large number of these units are flying all over the world. The 125 h.p. Major was introduced in 1935 and production commenced at Brough. The latest Major 150 was announced about this time last year.

Mr. C. S. Napier, the chief designer, believes in following the same line of development with all engines. This is roughly as follows: In the first place, on completion of the design, three engines are built. The first one is run and the inevitable first modifications which will be necessary are made. The second one, in modified form, following experience with the first, is placed on the test bench and thoroughly tested for both long and short periods. Most of the characteristics are by that time well known. If the engine appears to be shaping well and further alterations are likely to be only of a minor nature the third unit it put in an airframe and flown.

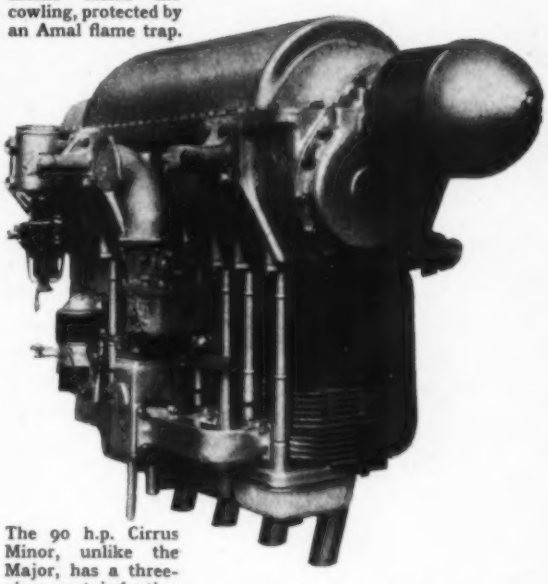
Snag-hunting

Engines which function excellently on a test bed sometimes behave quite differently in a machine, and, although most development work is done on the bench, the hours in the air are essential for the study of installation problems, the development of good flying qualities and simply as an endurance test.

Machines of all sorts have been used, but the Blackburn Bluebird and Hendy 302 have done most of the hard work. As an example of development work may be quoted some difficulties experienced with the valve design on the Minor, which caused a number of small modifications to be made. These included an increase in valve-stem diameter from 8 to 9 mm. and in the thickness of valve-guide material, to aid heat dissipation, from 2 to 3 mm. Push-rods were made from duralumin instead of steel to give better expansion qualities. (The



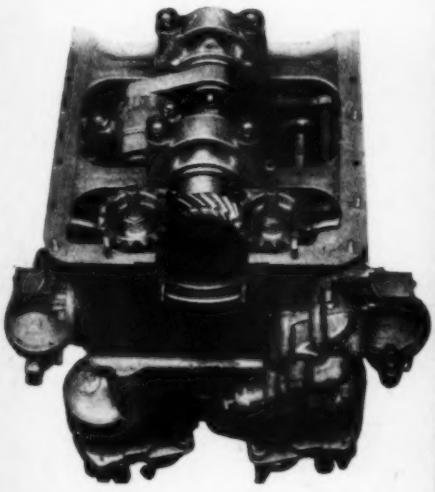
The Major 150, latest of the line of Cirrus Majors, has its air intake inside the cowling, protected by an Amal flame trap.

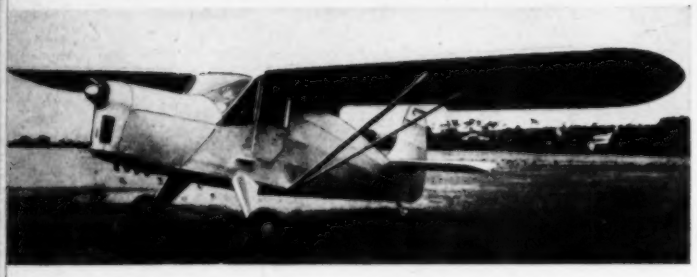


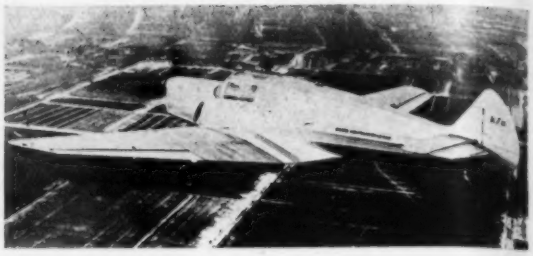
The 90 h.p. Cirrus Minor, unlike the Major, has a three-piece cast induction manifold. Two separate Amal fuel pumps can be fitted, as compared with a single dual pump on the Major.

(Below, left) At the rear of the Minor crankcase, two separate vertical shafts drive magnetos and fuel pumps from a skew gear or the crankshaft. The oil pump is driven from the camshaft. (Below) Mr. J. Gadd, of Cirrus, inspects a Major 150 installed in a Miles Magister.

"Flight" photographs.







Cirrus Minor engines have found their way to many distant lands ; (Top, left) The Latvian V.E.F.J.12, a neat little cabin monoplane ; below it is the Butler monoplane, which hails from Australia ; (Above) The Danish Kramme and Zeuthens' K-Z.II has a welded steel fuselage and folding wooden wings.

Minor, it will be remembered, has a cup at the valve side of the rockers, and in it is held a ball which has a flat on one side. This ball is free to move in the cup and the flat contacts the valve stem evenly during the whole rocker movement.) A run of 440 hours followed the changes, and but for complaints from the village it might have been more. Running periods varied from 7 to 42 hours non-stop, and the normal engine speed of about 2,300 r.p.m. was maintained. The power output varied between 78.4 and 81.3 h.p., and the fuel consumption was 4.74 to 4.92 pt./h.p./hr.

One run of this type frequently indicates other points which need observation and possibly attention. Runs of varying length are, in any case, carried out to observe lubrication generally and the functioning of the electrical equipment. Cylinder temperatures are observed and prolonged weak-mixture tests are made.

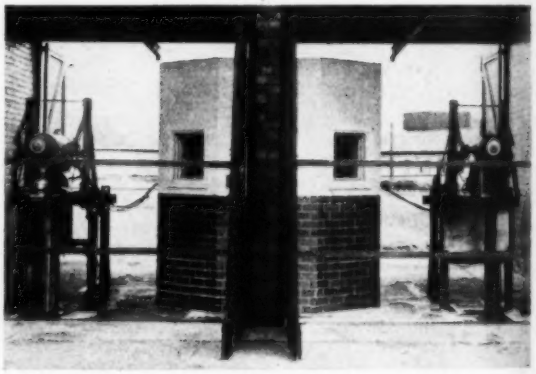
Test to Destruction

Finally, when an engine has reached the advanced stage and has completed some thousands of hours on the ground and in the air, a "failure test" is carried out in which a unit is run at full throttle with an airscrew until something *does* break. During the periods of running, normal adjustment is made and oil, fuel, grease, etc., are supplied, but no other work is done on the engine. Cirrus engines have always been produced with an eye to sturdiness even at the expense of additional weight, a good example being the forged Hiduminium connecting rods of large section. Incidentally, with a view to simplicity, a one-piece cast induction manifold is being tried on the Minor; this resembles that fitted to the Major. An engine so modified has run for a good number of hours.

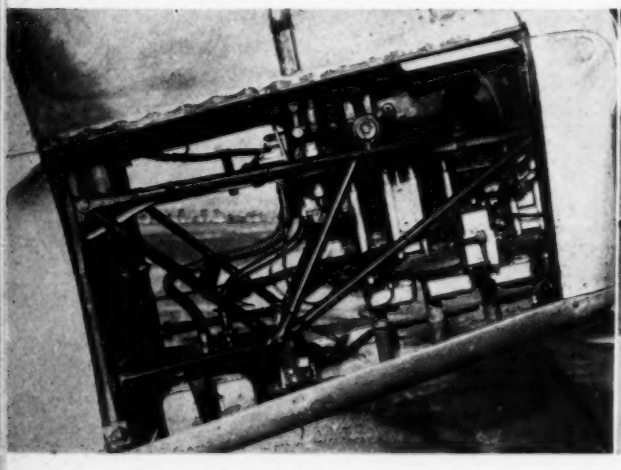
The Minor has been installed in several light British machines, including the C.W. Cygnet, Deekay Knight, a Wicko and, of course, the B.A. Swallow. In addition to the foreign machines illustrated on these pages, the Bücker Jungmann 131, d'Oplinter monoplane and V.E.F.J.8 and 11 likewise mount the Minor. Many Minors are flying in Chilean trainers, both in new machines and as replacements for early Hermes and other engines.

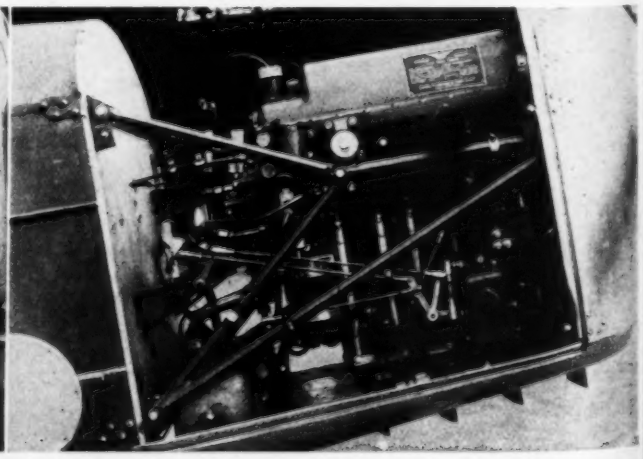
An important Air Ministry production order for the Major 150 has been received, and several units have already been installed in Miles Magisters. With 150 h.p. available, the Magister is distinctly lively.

The foresight shown by the company in producing the Minor—the only British light four of under 100 h.p. in production—should be amply rewarded as the number and popularity of small private-owner types increases.



(Above) A pair of new test houses at Brough. The common cabin is silenced even to the double windows, which are sealed with water between the panes. (Below) Two Cirrus Minor installations ; on the right in a B.A. Swallow and left, showing clearly the engine's small size, in a Blackburn Bluebird used for testing purposes.

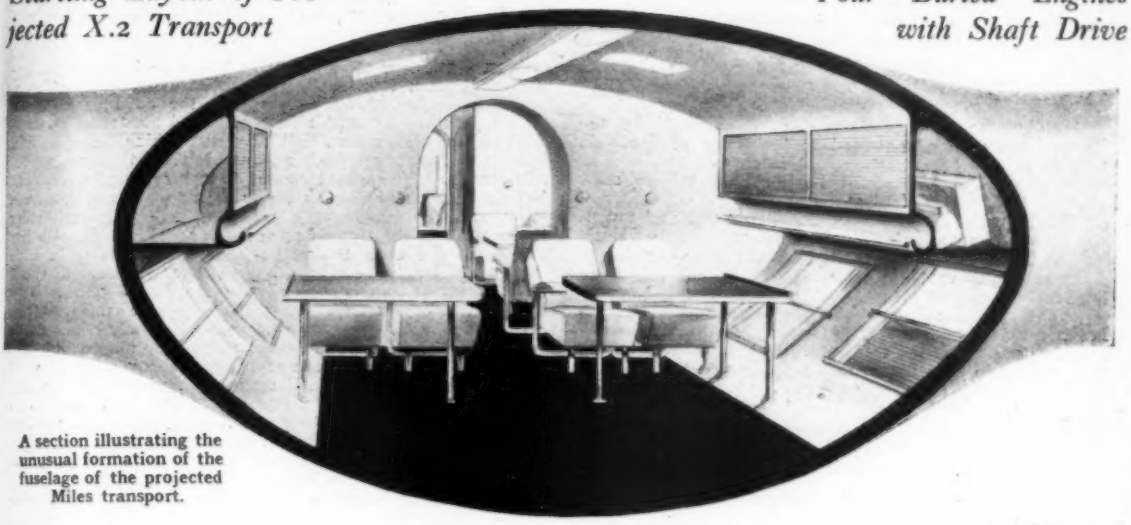




A SUPER MILES

Startling Layout of Projected X.2 Transport

Four "Buried" Engines with Shaft Drive



A section illustrating the unusual formation of the fuselage of the projected Miles transport.

PLANS for a somewhat unorthodox four-engined transport aircraft are well advanced at the Phillips and Powis Reading works. Mr. F. G. Miles, who is largely responsible for the commendable foresight the firm displays, is of the opinion that efforts to put British design ahead of competitors will fail if circumstances are allowed to force us into designing along too orthodox or too unorthdox lines. Accordingly, the design of the X.2, as the new machine is called, although representing a striking advance, does not bring in fresh problems of control and stability. Two years of work on the basic design have produced no reason for modification of the layout.

The following notes are selected from a preliminary specification lately released:

The aerodynamic design of the X.2 is described by Mr. Miles as a logical advancement on existing designs. The following drag analysis for the machine travelling at 250 m.p.h. and an all-up weight of 55,000 lb. has been made: Skin friction drag, 54 per cent.; induced drag, 11 per cent.; drag due to the wake, 21 per cent.; interference drag, 9 per cent.; cooling drag, 5 per cent. This gives an aerodynamic efficiency (defined as the ratio of the skin friction and induced drag to the total drag) of 65 per cent.

Fuselage Structure

The fuselage, which merges into the wing, is divided by the spars into three main compartments. It is of semi-monocoque construction with former rings and stringers. The design of the centre section spars is worthy of particular note: they virtually form two hoop-shaped bulkheads having same shape as that of the fuselage in their vicinity.

It is claimed that the space available in the X.2 layout is greater than on other aircraft of similar size. The total cabin volume is 3,068 cu. ft., of which 350 cu. ft. are allotted to baggage in the rear fuselage, with an additional 200 cu. ft. in the wing root. There is room for 2,500 gallons of petrol in the wing, but when the full load of petrol is not required about 400 cu. ft. of space may be used for additional baggage.

The wing structure is of stressed-skin type with two sheet-metal webs taking the shear, the skin being reinforced either with stringers or corrugated sheet, so that it can take not only a shear due to torsion and drag, but also the end load due to bending.

The tail is of modern layout with twin fins and rudders.

Tests are in progress on a special split flap design and a variable-area wing to facilitate take-off and landing. The undercarriage and flaps will be either hydraulically or electrically operated.

The X.2 will be fitted with a complete air-conditioning plant, introducing 17 cu. ft. of conditioned air per minute per person. It is hoped that it will be possible to employ a method of sound-proofing which, apart from producing noise, will lower heat losses.

Three typical "cases," or layouts, for the X.2 have been studied in detail. The first is for the aircraft carrying 38 passengers and 700 gallons of petrol; secondly, carrying 32 passengers and 1,400 gallons of petrol; and thirdly, with 18 passengers and 2,500 gallons of petrol. There are, of course, a number of alternative arrangements.

The pilot and second pilot are seated side by side in the nose, with the wireless operator close behind and near the second pilot. On long flights there will be provision for a navigator and a flight engineer. A door is fitted in the underside of the fuselage to obviate the necessity of the crew passing through the passengers' quarters when the machine is on the ground.

The engines selected are air-cooled units of a new type. Each unit is housed completely in the wing with shafts to the airscrews. Cooling is by slots in the leading edge. After passing round the engine the air is discharged at the trailing edge of the wing, adjustable flaps controlling the volume. A tunnel in the wing permits access to the engines during flight.

The proposed wireless installation for long-range work is the Marconi Type AD 67A/6872B/5062C/626B, as used for transatlantic crossings by the Empire boats. Direction-finding and visual course indication are catered for by an additional receiver, a rotatable loop and a visual indicator.

Goodrich pulsating de-icing equipment has been chosen in the first instance.

It is proposed to build a reduced-scale prototype carrying a pilot and observer together with research apparatus. With four Menasco C-4 engines the following data should be obtained: Tare weight 2,000 lb., gross weight 2,840 lb., wing loading 14.2 lb./sq. ft., power loading (125 h.p. per engine) 14.5 lb./sq. ft.

MILES X.2 TRANSPORT

Dimensions:	
Span	99ft.
Length	78.8ft.
Max. cross-section of fuselage	115 sq. ft.
Wing area	1,762 sq. ft.
Aspect ratio	6
Weights and Loadings:	
Max. allowable all-up weight	61,128 lb.
Max. wing loading	35 lb./sq. ft.
Performance: (At 47,555 lb.).	
Top speed at sea level	262 m.p.h.
Top speed at 11,000ft.	301 m.p.h.
Top speed at 25,000ft.	280 m.p.h.
Max. cruising speed at 11,000ft.	280 m.p.h.
Max. cruising speed at 20,000ft.	260 m.p.h.
Stalling speed at sea level with flaps	76 m.p.h.
Stalling speed at sea level with split flaps	65 m.p.h.
Climb to 11,000 ft.	9.6 min.
Absolute ceiling	30,000ft.
*Range at 45 per cent. power in still air	1,200 miles at 11,000ft.
Take-off run at sea level	465 yd.
Top speed on three engines at 11,000ft.	260 m.p.h.
Service ceiling on three engines	21,000ft.

* The maximum range at 61,128 lb. will be about 4,300 miles.

CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

BROADSIDE FIRE

Mr. North Still Wants Data

I AM obliged to your correspondent "Tactician" for the further information contained in his letter published in your issue of April 7.

In order to make some useful deductions there are still some of my questions to be answered:—

(a) What kind of target was employed, e.g., ground target, towed target, or screens, bearing in mind the fact that something was to be presumably observed outside errors of pointage and corrections for relative speed?

(b) At what range or ranges was the effect observed?

(c) What was the nature of the effect observed?

I regret that I am not at the moment able to make any comments on the question with regard to the Cazaux effect on altitudes as up to the moment I do not know what the Cazaux effect is, or even if it exists. JOHN D. NORTH.

Bridgnorth.

AIRCRAFT EXPORTS

—and the Dictatorships

IN connection with the conversations now taking place between the Government, the Engineering Employers' Federation and engineering unions on the question of ways and means of accelerating rearmament, it has been suggested that Britain has exported considerable quantities of aircraft to what are generally referred to as "the dictatorships."

The official figures show the destinations of our aircraft exports, which totalled last year 507 complete aeroplanes and 388 aeroplane engines. Of the aeroplanes, 238 went to British Dominions and Colonies; and of the engines, 225, Australia being the largest individual buyer of aeroplanes and the Union of South Africa of engines. Of the remainder, France took 31 planes and 11 engines; Belgium 25 and 27 respectively; the Netherlands 6 and 68; Greece 14 and 24; Iraq 20 and 19; and Persia 27 and 4. Germany purchased from Britain one aeroplane and two engines; Japan one aeroplane and 23 engines; Soviet Russia and Italy no aeroplanes and no engines.

It is to be hoped that the publication of these facts will refute once and for all the assertion that the British aircraft industry is supplying large quantities of military planes and engines to the dictatorships. J. BAKER WHITE,

London, S.W.1. Director, The Economic League.

WOMEN INSTRUCTORS

A Considered Opinion from One of Them

I HAVE read with interest the letter of "Pilotess" in your issue of April 7, suggesting that women might be employed, in time of war, for *ab initio* Service flying training. It seems that there are three aspects of her question:

(1) Can women teach flying?

(2) If so, could they maintain discipline up to Service standards amongst a class, type and age of male the most resentful of constituted authority?

(3) Again, if so, would they be available in sufficient numbers to be useful as a body, as opposed to individual exceptions.

Let us take No. 1 first. That there was no sex disqualification to the G.A.P.A.N. Instructors' Certificate seems to postulate an official theory that women can teach flying. Since, however, this view was adopted in advance of any practical experience of the subject it can only rank as negative evidence. In the result, three women (I believe) obtained the certificate, and two of them have to my knowledge practised instruction successfully over a period. They do not make much of a summer, these three, but at least they provide some positive evidence.

The second question is more difficult. Such evidence as exists was obtained under club conditions, where the pupil is also the customer, with a buyer's point of view, and the consequent right to ruffled plumage, where the ultimate tribunal was a rather weak committee more concerned about the balance sheet and the quantity rather than the quality of its flying members. Whilst all these factors tended to increase the difficulty there was the advantage that a man who is paying for his flying, and whose average age is probably a little greater on that account, is more amenable to reason than the youngster of eighteen to twenty, with his wild oats still unsown.

The instructor always starts with the advantage of his pupil's spontaneous respect for a (relative) master of his subject, coupled with a very natural wish to shine. The woman instructor has the added advantage that this respect is enhanced by her supposed greater difficulties in acquiring that (relative) mastery and with the instinctive desire of the male to impress the female. By tactfully and subtly indicating the conduct in the air and on the ground which does win her confidence and does impress her, she can obtain it in nine cases out of ten, and in the face of such a proportion she could certainly count on disciplinary measures for the tenth.

The third aspect represents the crux of the whole matter. It is arguable that since of good men pilots only a few make good instructors, amongst women (where the number of good pilots is a lower percentage of pupils) the quantity of good instructors would be so small that there could be no justification for spending public funds in discovering them. Conversely, it may be held that in the absence of free training facilities, women pilots hitherto have consisted only of those with large enough bank balances, and that the training in numbers of women of similar age level and of the same physical standard as R.A.F. pilots would yield a comparable proportion of good pilots.

Both views have necessarily remained conjectural in the absence of any such experiment, but the newly formed Women's Air Patrol of this club, which has already some sixty members, is going to provide the first instance of large-scale training of women pilots as such, and it should be possible in about a year's time to form a definite opinion. There is, of course, no question of medical selection, at any rate beyond the A Licence standard, nor is there at present any intention of training them beyond a club-passenger-carrying standard, but at least the average age is right, since all but a very few are in their late teens or early twenties.

It may be as well to explain that there is no question of training them free of cost, but by providing them with the facilities for raising funds of their own, by means of social events and organised appeals, the charges for instruction have been brought down to 15s. an hour to the individual member, a level which opens up flying to a very much greater number of girls than the usual rate of £2 per hour.

London, N.W.11. (MRS.) G. M. PATTERSON,
Instructor, Romford Flying Club.

GUSTS

"Indicator" Taken to Task

"INDICATOR'S" notes in *Flight* of April 14 (p. 362) are very interesting in the respect that they show complete lack of knowledge of wind currents. If "Indicator" would take the trouble to come and visit Ely Aero Club on a very windy day, he would learn a lot by either observation or trial by watching or flying a Drone.

Owing to the inherent stability and feathery lightness of the Drone, it is common for instruction to be given to *ab initio* pupils when the wind is so strong that other aerodromes have to keep their machines in the hangars. It is a common occurence locally to see a Drone leave the ground before it has travelled its own length after opening the throttle, and climb vertically upwards for a short period and then travel backwards at a considerable velocity. Experienced pilots, through their complete ignorance, would say that this was highly dangerous. It would be dangerous if wind variations of the order of 30 m.p.h., mentioned by "Indicator" existed. Such conditions do exist near obstacles such as banks of trees or houses.

The fact that the difference in the cruising speed and the climbing speed of the Drone is only 5 m.p.h., proves that the differences in air speed mentioned by "Indicator" do not occur, otherwise it would not be safe to fly the Drone regularly in gales, as is done by this club. Variations up to 10 m.p.h. are rare, and up to 15 m.p.h. are occasionally found, but this is not enough to upset the Drone.

What every pilot should understand is that in conditions of high wind the friction of the earth causes the velocity of the air to be progressively reduced near the ground. The variations in velocity are greatest during the first 30ft., but are still noticeable up to as high as 150ft. The condition mentioned

by "Indicator" of a ground speed of 25 m.p.h. and 45 m.p.h. at 2,000ft. is about normal. This greatly assists take-off into wind, especially when flying a fast machine which unsticks at 55 m.p.h. If the machine is held down after taking-off until normal climbing speed is reached, the stick may be pulled back and held back. While the machine climbs to 100-150ft., it is meeting air of an increasingly greater velocity and the climbing air speed will be found to remain the same, although the machine is being climbed at an alarmingly steep angle. Above the 150ft. the rate of change of velocity of the air is comparatively small, and the climbing angle requires to be eased off in order to maintain the normal climbing rate. The majority of private pilots have realised that the machine appears to drop during the last 150ft. of the glide into land, and they will have been taught by the instructor that they must have extra speed. Very few pilots realise that the extra speed is necessary to make up for the sudden change of velocity of wind which occurs when levelling out and when the pilot is no longer watching the air-speed indicator.

When flying a Drone one can *feel* every little variation of wind current, and the climb of a Drone in windy weather by an experienced pilot appears to be very ragged, as he makes use of every slight gust of wind to increase his climbing angle and height. Up to 1,000ft., quite prolonged down-draughts exist and the Drone often loses height while attempting to climb. With wind-cum-thermals, extraordinary rates of climb can be maintained. On one particular occasion two pilots flying two Drones, each with recording barographs, ascended on the same thermal whilst circling each other and using only one-quarter throttle, from 600ft. to 5,000ft. in 4 minutes. I have personally made use of thermals to do journeys of 20 miles or more with the engine switched off completely.

In the Drone one is really *flying*, and not just doing mechanical operations. May I repeat my invitation to "Indicator" to come and *learn to fly* at Ely. His subsequent written observation would probably do a lot to kill the objectional prejudice which is met with everywhere on the subject of flying ultra-light aeroplanes. H. R. DIMOCK.

Ely, Cambs.

["Indicator" comments: "Oh, Mr. Dimock! If he reads my remarks again he will see that the wind variations are, so to speak, on a *downward* grade—*i.e.*, 45 m.p.h. at 2,000ft. and 25 m.p.h. All I said was that in certain conditions the change in wind speed occurs fairly suddenly and the machine's air speed consequently drops rapidly until ground speed has been picked up.

"In Mr. Dimock's own words, 'a Drone climbs vertically upwards . . . and then travels backwards at considerable velocity.' There you have the variations of which I spoke. These variations cannot, obviously, be instantaneous, but they are quite marked when one is flying a machine with a steep glide and a strong climb. The Drone passes more slowly through the levels of change and has time to adjust its ground speed to the new conditions. For the rest, Mr. Dimock's letter entirely supports my contentions.

"And one day I really will learn to fly. Searching through the type-names in my log-book I find that I have put in 7hr. 30min. on ultra-lights. Hardly enough, I fear."]

FRONTOLOGISTICS

More About Navigational Niceties

WITH reference to Mr. Martin's communication appearing in *Flight* of April 7 (page 345), I would like, at the outset, to state that my letter of March 10 was not written with the sole purpose of bombarding Mr. Martin with criticism, but merely as an endeavour to dispel the gloom which I consider he had cast over the realm of prospective navigators.

Mr. Martin has misconstrued several of my remarks and has issued what, in my opinion, constitute ridiculous challenges. I did not, for example, quote "constitute astronomical navigation" as a phrase employed by him; those were entirely my own words and were employed to show that Mr. Martin's article was liable to lead prospective students and candidates to believe that the subject of astronomical navigation now formed part of the second class syllabus.

I regard Mr. Martin's challenge with reference to the application of the hour angle as absolutely absurd, in view of the fact that I expressed quite clearly the opinion that the syllabus was not perfect; in fact, I consider that there is quite a lot of room for improvement so far as the whole examination is concerned. My criticism under this heading was to the effect that Mr. Martin's article gave readers the false impression that the calculation of hour angles was an involved problem, and that the introductory elements of astronomical navigation included in the syllabus were not only difficult of mastery but useless. Anyone connected with even elementary instruction in navigation is aware that the hour angle is a necessary factor.

In view of certain statements made by Mr. Martin I would like to point out that when I commented on that gentleman's article I did so as one who has had considerable practical experience, not only as a navigator but also as a meteorologist and, incidentally, as a *frontologist;* that being the case, I am *very strongly* opposed to the inclusion in any syllabus of any unnecessary theory. I do, however, realise the great necessity for improvement and advancement of navigational knowledge generally, and the science cannot be fully developed unless various theories which have definite places in actual navigation are accorded simple presentation, careful study and efficient application.

With regard to the question of fronts, had I stated, or even inferred, that Mr. Martin evolved the terms "frontology" and "frontologists," I would have been guilty of a highly ridiculous and inexcusable error. He most certainly has not any claim in that direction; the fact that he had, in my opinion, misused them caused me great surprise. The term "frontology" refers to a modern branch of meteorology, and the status of a "frontologist" is a little higher than that of an inserter of fronts on synoptic charts. The question raised by Mr. Martin of international differences of method is entirely irrevelant so far as the syllabus under criticism is concerned.

In reply to Mr. Martin's concluding paragraph, I would like to point out that qualified, up-to-date dentists do not hurt their patients in the practical application of their work.

Perth Aerodrome. H. W. SIMS-WHITE.

[This correspondence is now becoming unduly protracted, and the letter above must, we are afraid, be the last word.—ED.]

MILITARY AIRCRAFT SPEEDS

A Plea for Officially Admissible Record Attempts

YOUR correspondent, M. J. West (p. 346, April 7) is, of course, quite right in his comments on the alleged performance of the Hawker Hurricane.

But I would like to point out to him that although the Supermarine Spitfire is advertised as "the fastest military aeroplane in the world," that statement also leaves something to be desired.

Germany holds the world's record, under official observation, for the speed of a military type aeroplane.

As neither Hawkers nor Supermarine have got confirmation of their claims one is forced to place their assertions in the same category as those of Kipling's Bander-Log. ("We all say so; so it must be true.")

Seriously, as *Flight* has a world-wide circulation, would it not be better for our aircraft makers to support their claims in some proper manner so that foreign nations have FACTS about our machines? JOHN V. HEWES.

Ashstead, Surrey.

THE POOR PRIVATE OWNER

Subsidised Hangarage?

ON the subject of private ownership, surely "Indicator" is wrong in assuming that flying clubs lose the flying subsidy when a member buys his own plane. My information is that the club continues to draw a subsidy per hour if the aircraft is stationed on their premises. Perhaps you will make the matter clear to us. [That is so, provided that the owner is a member of the club.—ED.]

As I am easily the poorest P.O. on record I am vitally interested in the subsidy question, although one recognises that to the general public this must sound rather like subsidising yachting or hunting. The question of what form the subsidy might take is not a simple one, as "so much per hour" does not achieve any real end except burning petrol, and is also very open to fraud.

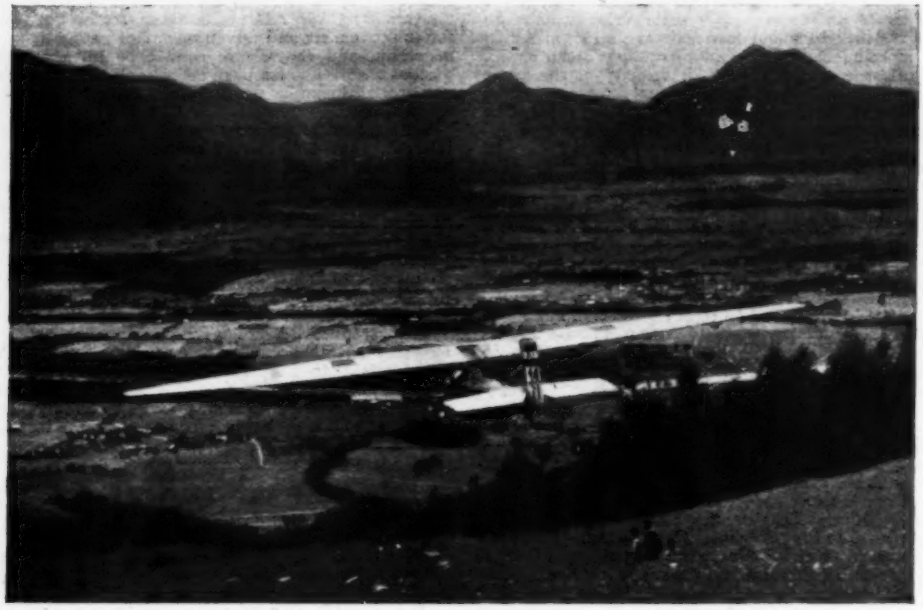
I would suggest that if the Government would guarantee to pay housing charges at standard rates one of the major snags of private ownership would be immediately overcome. Aerodrome proprietors would benefit and would be encouraged to enlarge their premises and to cater for private owners instead of regarding them as rich nuisances who deserve to be stung.

The subsidy would be in the neighbourhood of £50 p.a. and would, of course, be applicable to P.O.s keeping their planes in private landing grounds, provided these were available for use all the year round, and conformed to certain standards in the matter of dimensions, surface, etc.

Obviously, here is a means of breaking the vicious circle (no planes; no landing grounds; no planes) in two places. Increase the landing grounds and the number of private owners simultaneously so that neither is waiting on the other, and they will react on each other to bring about further increase, all at a really trifling cost. W. B. SHAW.

Ipswich.

PRIVATE FLYING



Topics of the Day

Forced Landings

WITH all these Reserve aeroplanes hurtling through the sky in the vicinity of nearly every aerodrome in the country the chances of practising aerodrome forced landings become fewer and fewer. For some reason or other—perhaps because in the very early days I was firmly told that such practice must not on any account be carried out without an instructor—it rarely occurs to me to go and find a large field well away from all this activity. Possibly I imagine, quite reasonably, that some large and prickly obstruction might suddenly appear just as the hedge is being crossed; certainly, the average aeroplane is peculiarly blind in many directions.

However, a week or two ago I attempted an imaginary forced landing (following all the rules) into an aerodrome which was no larger than a normally big field. I made it without using the engine and without using more than 150 yards of the field, but any instructor would have described the performance as "rather unorthodox." After S-turning my way down I found that if one more turn was made I should then have lost too much height, while if I flew straight in it would not quite be possible to slip off all the excess height. So I made the last turn while skidding away from the field and completed the approach with a more or less conventional, but decidedly unpretty, piece of crazy flying.

During all this unorthodoxy, which, nevertheless, did the trick, it occurred to me that it is possible to waste a tremendous lot of physical and nervous energy in this business of a forced landing approach. With a machine which does not sideslip too satisfactorily it is difficult to keep the speed down, and the whole thing may become rather melodramatic. In four cases out of five there is probably no need for all these violent manœuvres if proper use is made of any wind which is blowing. If you find that you are tending to overshoot, it is only necessary to slow down the glide, and you will find that the excess height is lost very rapidly. Not only is the still-air glide-path actually steeper, but one is thereby taking the greatest possible advantage of the wind effect.

The surest way to overshoot at any time is to glide too quickly. The modern machine is very safe indeed when flying at a low speed provided that no violent control movements are made, and the risk of dropping the machine is probably a good deal less than that of hitting some unseen tree while executing a steep turn or a violent crab-sideslip when fifty feet off the ground. And I am not forgetting that it is more dangerous to undershoot than to overshoot. Common sense must obviously come into it. All I say is that there is often no need for all this violence.

The New Technique

I ORIGINALLY learnt just how important gliding speed could be when flying a very lightly loaded low-wing monoplane for the first time. This machine was renowned for its safety at the stall, and it was possible on a reasonably smooth day to adjust the approach entirely by letting the machine fly quickly or slowly according to the circumstances, putting the nose down to stretch the glide and pulling it up to shorten it.

This technique, in fact, is that used by Autogiro pilots, who usually make the first part of the approach a vertical descent with the stick back and then put the nose down to gather the necessary speed for landing. Once one becomes accustomed to this rather reversed order of the proceedings it seems quite natural.

An alternative method of making an engineless approach without recourse to steep turns and sideslips can be applied in the case of a machine with strong air brakes or flaps. With one or two types it is possible to glide almost at a diving angle without exceeding a certain quite reasonable air speed, and all that is necessary is to point the machine at the boundary hedge and then find some means of getting rid of the excess speed. In any case it is not a serious matter (except to the underwriters) if the outfit rolls on into the opposite hedge; at least one is on the ground.

Needless to say, the flap fittings must be strong, and I always think that it is an admission of failure somewhere if there is a large notice on the dashboard to say that "this machine must not be flown at speeds in excess of x miles an hour with the flaps down." The flaps should

PRIVATE FLYING (CONTINUED)

be powerful enough to prevent speed from exceeding the stipulated figure and should then be strong enough to deal with this speed. The whole point is that the old technique of forced landing approach cannot always be applied to the present-day types, and other methods must obviously be used.

Ground Control

TALKING about all this Reserve flying, the people at one or two aerodromes are beginning to feel rather worried about the inevitable congestion. The difficulty does not concern the number of machines actually in the air, but rather those on the ground. In the air the pilots must obviously look after themselves, while keeping as far as possible to the normal rules.

At one aerodrome, at least, the powers that be are going to attempt to put the area system into action—one part of the landing area being used for take-offs and another for landings. The machines will need to be taxied round the boundary each time to the take-off position, and as it is a very large aerodrome the bill for tyres, undercarriage fittings and tail skids will probably be fairly high.

The major problem appears to be that of organising a take-off signal. The aerodrome is not quite level and the far boundary is two-thirds of a mile away from the control centre, so an Aldis lamp would probably be ineffective unless a special tower was erected and electrically heated control officers left there for eight-hour shifts—the other members of the staff taking away the ladder to ensure that they were always on duty. They will probably end up by having a special flag-man out on the aerodrome. I should hate to be in his shoes. Early soloists are usually satisfied to get down anywhere on an aerodrome and are much too busy judging their height above the ground and generally dicing with death to bother very much about an odd flag-man or other. He will probably spend half his time lying on his stomach with his flag fluttering furiously above his head.

INDICATOR.

FROM the CLUBS and SCHOOLS

READING

THE machines of the Reading Aero Club were very busy over the Easter week-end. Mr. R. Flower went solo and three new pupils joined the club.

MARSHALL'S

Cross-country flights to Rochester, Hatfield and Luton were made during the week ended April 17 and 62 hours were flown by club aircraft. Mr. Tolson joined the school and Miss Marshall made her first solo.

BROOKLANDS

The entire club fleet of Tiger Moths recently paid a luncheon visit to the Romford Aero Club, the flight being made in formation. Twenty-six new members have been elected, including General Viscount Gort, V.C.

SOUTH COAST

The South Coast Flying Club will hold a Dawn Patrol on May 1 to which all clubs are invited. The pilot's height-judging competition closed on April 17 and a new competition will shortly be announced. Mr. M. B. Smith has qualified for his "A" licence, while Mr. Bellairs has purchased a new Whitney Straight. Encouragement is given to private owners, the number of whom are increasing.

COUNTY

Twenty-six new flying members joined the County Flying Club during last month, in which the flying time totalled 72 hr. 30 min. First solos were made by Mrs. H. G. Truscott and Messrs. E. W. Hall, R. H. Hurst, and R. Hartopp, while "A" licences were obtained by Messrs. S. Love and V. Hartopp. The club uses two Taylor Cubs and the flying rates, consequently, are extremely low—from 17s. 6d. to £1 an hour.

STRATHTAY

With an improvement in the weather, flying times for the week ended April 10 went up to 12 hours. Messrs. Scarlett and E. T. Halley made a long week-end trip to Paris in the Swallow. Mr. George McLean made his first solo.

SOUTHEND

A demonstration of the Taylorcraft was given at the aerodrome on Sunday. Mr. George Percival made his first solo flight and later in the week completed his "A" licence tests. Flying was well up to average in spite of the rather gusty weather.

NEWCASTLE

First solo flights were made by Messrs. W. Clayton and J. Whittaker during the week ended April 10, and cross-country flights were made to Brough, Heston, Carlisle and Edinburgh. Flying, including 15 hr. 55 min. dual instruction, totalled 66 hr. 35 min.

YORKSHIRE

The summer joy-riding season started on Good Friday, when quite a number of people were given flights. The total flying for the week ended April 15 was 77 hours, while for the month 106 hr. 20 min. were logged. Charter trips were made to Yeovil and Doncaster.

HANWORTH

The second dawn patrol at Hanworth will be held on Sunday next, April 24, between 8.15 and 9 a.m. The programme of flying and social events for the second half of 1938 will be available shortly. Messrs. F. Embleton and N. W. F. Moore have completed their "A" licence tests and Mr. Man Mohan Singh, the first Indian to fly to India, is taking a blind-flying course at the club. A total of 92 hr. 35 min. represented the flying for the week ended April 17.

More "Goal" Soaring

AFTER being launched in a Kirby kite from one of the Newcastle Gliding Club's soaring sites about thirty miles north of Newcastle, Mr. S. C. O'Grady, the chief instructor, flew over to Sutton Bank on April 3. The distance is about seventy miles and the route lies directly over Newcastle and Middlesbrough. This is probably the first time in which what is known as a "goal" flight has been carried out between two gliding clubs. Mr. O'Grady was in the air for about 2½ hours and flew through a snowstorm at about 6,000 feet.

To the Isle of Man

DETAILS of the minor changes which are being made in this year's Isle of Man races, the third series to be held, have already been given in *Flight*, but for those pilots who have not previously flown in these events, certain brief particulars might be given.

The London-Isle of Man race, which will be held on Saturday, June 4, is an international handicap event, and will be started this year from Hatfield aerodrome; in the two previous years the start was from Hanworth. There is a compulsory stop of an hour at Liverpool (Speke) and the turning points will be at Blackpool (Stanley Park) and St. Bees Head lighthouse, from which competitors will fly straight to the finishing line at Ronaldsway aerodrome. Between 2 p.m. and 5 p.m. there will be a surface patrol of the sea.

The Manx Air Derby and the Tynwald Air Race, each of which is over a course consisting of three left-hand circuits of the Island, will be held on Monday, June 6. The former is for machines with engines exceeding a total of 120 h.p., and the latter for those of lower power.

The prizes for the long-distance race will be £125, £75 and £50, with a challenge cup presented by Germ Lubricants for the winner; those for the Manx Air Derby will be £100, £50 and £20, with a challenge trophy also for the winner; and those for the Tynwald Air Race will be £50, £20 and £10. The organising manager is Capt. R. H. Stocken, Eagle House, 109, Jermyn Street, London, S.W.1.

The Lympne Rally

WHEN last year's International Rally at Lympne was described we suggested that this Rally might, unfortunately, be the last to be held by the Cinque Ports Club. The whole business had really become too much for a club, even for such an energetic and well-supported one as that at Lympne.

And now we learn from Mrs. W. E. Davis that this Rally has, in fact and officially, been cancelled. Let us hope that the Royal Aero Club will do something to fill the gap.

The Folkestone Aero Trophy Race will, of course, be held as usual at Lympne on July 30, while the Cinque Ports Wakefield Cup race will be flown on September 3. Information concerning the courses and entry fees will be given in due course.

THE INDUSTRY

Tyre Procedure

THE latest additional loose leaves for the *Dunlop Aeroplane Equipment Manual* (Aviation Department, Fort Dunlop, Birmingham) deal with the fitting of tyres to detachable-flange hubs.

Oil and the F.B.I.

FOR the tenth year in succession Mr. H. Bell Thompson, managing director of Sternol, Ltd., the well-known oil refiners, has been elected to represent the lubricating oil trade of the United Kingdom (Main Group 17) on the Grand Council of the Federation of British Industries.

Forty Years of Bearings

THE many intricate processes involved in ball and roller bearing manufacture are described and illustrated in a most interesting fashion in a booklet recently issued by the Hoffmann Manufacturing Co., Ltd., Chelmsford, to celebrate their forty years of existence.

Mr. D. B. Mirk

MR. D. B. MIRK, lately radio manager of Standard Telephones and Cables, Ltd., recently received presentations from his colleagues and the radio-shop employees on resigning in order to become a partner in the firm of Urwick Orr and Partners, Consulting Industrial Engineers, of St. James's Square, London, S.W.1.

"Going Up, Please"

MANY a ft.-lb. of tedious work must have been swiftly and conveniently dealt with by one or other of the Morris lifts. Several different models of passenger and goods lifts for flats, factories and warehouses have been installed, not to mention less elaborate hoists, hand or electrically operated, for use to cellars or basements. The firm of Herbert Morris, Ltd., has its works at Loughborough.

The Right Way

A PRAISEWORTHY policy of exploiting the export trade without neglecting the needs of the Air Ministry, or vice versa, has been consistently pursued by the Williamson Mfg. Co., Ltd., and a photograph received by *Flight* shows that there is no weakening of that attitude. A large and a small lorry, piled high with crates, are seen leaving the Willesden works for the docks. In the crates are over six tons of "Eagle" aircraft cameras.

The Aspin Engine

A REVISED edition of the Aspin rotary-combustion-chamber engine is nearing completion. The flat-four arrangement is preserved and the same cylinder blocks and heads are used. A three-throw crankshaft, however, will replace the original two-throw shaft to eliminate a couple which was apparent when the unit was flexibly mounted.

Since the new crankshaft necessitated a redesigned crankcase the opportunity has been taken to set the two magnetos transversely at the rear instead of on top of the case at the forward end, thus bringing the c.g. back or down somewhat.

FOR METALLURGICAL RESEARCH: Sir William Bragg, O.M., D.Sc., F.R.S., famous for his X-ray metallurgical investigations, is the first recipient of the new medal of the Institute of Metals, awarded for outstanding services to non-ferrous metallurgy. The medal, obverse and reverse of which are seen above, was designed by Harold Stabler and made of pure platinum by the Mond Nickel Co., Ltd. A silver reproduction, by the Goldsmiths and Silversmiths Co., Ltd., is being presented to the British Museum.

PUBLICATIONS RECEIVED

Cooks Holidays Abroad, 1938. Thos. Cook and Son, Ltd.

Air Rule of the Road and Air Legislation, by Lt. Cdr. R. Sunnucks, 8s. Brown, Son and Ferguson, Ltd., 52-58, Darnley Street, Glasgow, S.1.

The Air Annual of the British Empire, 1938; 21s., Sir Isaac Pitman and Sons, Ltd.

The Air Almanac; Ephemeral Sheets for 1938, *April* 1 *to July* 1; 2s. 6d., H.M. Stationery Office.

Twenty-third Annual Report of the National Advisory Committee for Aeronautics, 1937; 15 cents, Superintendent of Documents, Washington, D.C., U.S.A.

The Climate of the British Isles, by E. C. Bilham; 21s., Macmillan and Co., Ltd. St. Martin's Street, London, W.C.2.

Magneto Manual, by H. R. Langman, 6s., The Technical Press Ltd. Ave Maria Lane, Ludgate Hill, London, E.C.4.

Handbook of Aeronautics, Vol. 1, Third edition; 30s. Sir Isaac Pitman and Sons Ltd.

Birmingham Auxiliary Fire Service (Air Raid Precautions Monthly Review). Fire Brigade H.Q., Corporation Street, Birmingham, 4.

Airplane Maintenance, by J. H. Younger, A. F. Bonnalie and N. F. Ward, 10s. McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2.

NEW COMPANIES

In the notes below, for reasons of space, the "objects" of new companies are usually somewhat abbreviated.

AIR SCHOOLS, LTD.—Private company. Registered April 7. Capital, £4,000 in 4,000 shares of £1 each. Objects: To carry on business as instructors in aviation, aerial navigation, aerial and ground signalling, dealers in and importers and exporters of aircraft and aircraft engines of all kinds, etc. The permanent directors are:—Norman R. Harben, D.F.C. (director of Frillcard Manufacturing Co., Ltd.); Air Commodore B. C. H. Drew, C.M.G., C.V.O., C.B.E. (retd.) (director of Avimo, Ltd.). Registered office: 4, New Court, Lincoln's Inn, London, W.C.2.

WITNEY AERODROME, LTD.—Private company, registered April 7. Capital, £3,000 in 3,000 shares of £1 each. Objects: To carry on the business of proprietors of aerodromes, hangars, repairing and petrol filling stations, etc. The permanent directors are: Mrs. Beatrice S. Macdonald, The Hythe Croft, Eynsham, Oxon. Ernest B. Taylor, 75, High Street, Witney.

DUGOUTS, LTD.—Private company, registered April 9. Capital, £1,000 in 1,000 shares of £1 each. Objects: To carry on the business of manufacturers of dugout and all concrete products, including shelters against all forms of aerial attack. The first directors are not named. Solicitors: Warren and Warren, 31, Bedford Row, London, W.C.1.

AERONAUTICAL PATENT SPECIFICATIONS.

(The numbers in brackets are those under which the Specifications will be printed and abridged, etc.

19276. BENDIX AVIATION CORPORATION: Brakes (481,594).

25580. BENDIX, LTD., and ROBERTS, G. P.: Control of Aircraft brakes (481,940).

32201. CONTRAVES AKT.-GES.: Method for measuring photogrametrically the aiming and firing error in firing exercises against moving targets, more especially aircraft, and apparatus for carrying out the method (481,820).

10071. SERVO-FREIN DEWANDRE SOC. ANON: Remote control apparatus for the successive release of bombs in aircraft (481,694).

17014. JUNKERS FLUGZEUG-UND-MOTORENWERKE AKT.-GES.: Mounting and sighting guns on aircraft and other vehicles (481,649).

26125. JUNKERS & Co., GES.: Combustion product outlets of gas-heated appliances (481,720).

Forthcoming Events

April 21. R.Ae.S. Lecture*: "High Altitude Flying," by Prof. A. E. Younger.
April 28. R.Ae.S. Lecture*: "Factors Controlling the Development of Electrical Ignition on Aero Engines," by Dr. G. E. Bairsto.
April 30. Aero Golfing Society: R.A.F. Match, Felixstowe.
May 8. R.Ae.S. Garden Party, Great West Aerodrome.
May 14-22. Finnish Aero Show, Helsinki.
May 17. Air League of the British Empire: Annual Dinner, Grosvenor House, London.
May 17. Aero Golfing Society: "Flight" Trophy, Royal Ashdown Forest.
May 28. Air League of the British Empire: Empire Air Day.
June 11. Bristol and Wessex Aeroplane Club: Garden Party.
June 18 and 19. Brooklands Four-club "At Home."
June 25. Official opening of Wolverhampton Airport.
June 30. Aero Golfing Society: Jubilee Cup, Prince's Sandwich.
July 2. R.Ae.C.: King's Cup Race.
July 16-18. Deauville Rally.
July 16. Official opening of Luton Municipal Aerodrome by Secretary of State for Air.
July 30. Official opening of Exeter Airport.
July 30. Folkestone Aero Trophy Race, Lympne.
September 3. Cinque Ports Wakefield Cup Race, Lympne.
September 21. Aero Golfing Society: Cellon Trophy, Richmond Golf Club.
November 18-December 4. Paris Aero Show.

* All these lectures take place at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, beginning at 6.30 p.m.

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STRENGTH OF WOODEN SPARS—II

Method Extended to I-Sections and Box-Sections

By J. H. PAYNE, B.Sc., A.C.G.I., D.I.C., A.F.R.Ae.S.

(*Continued from page 23*).

IN the first part of this article (*The Aircraft Engineer*, March 31, 1938), spars of solid rectangular section were considered. Using an "idealised" stress-strain diagram for spruce, the strength of such spars was obtained for any combination of end load and bending moment.

The same assumptions are now applied to an "I" or a box-section beam in which the web or webs are relatively thin, and serve mainly to carry the shear loads (Fig. 6). The resistance of such a beam to bending will be considered to be provided entirely by the flanges.

Stress Distribution

There are three possible types of stress distribution, depending upon the position of the "yield line." In the first, the yield line occurs in the compression flange; in the second, between the two flanges; and in the third case, within the tension flange. These three cases are shown in Fig. 7 (a), (b) and (c).

The first general equation (see the first part of this article), which expressed the equality of the flange loads due to bending, may be shown to reduce to the following forms:

$$\text{Case (a)} \quad \frac{X_o}{H} = \frac{n^2 + (1-n)^2}{n + 1 + \frac{4nf_c}{f_t + f_c}} \qquad 10(a)$$

$$\text{Case (b)} \quad \frac{X_o}{H} = \frac{n}{2} \cdot \frac{f_t + f_c}{f_t - f_c} \qquad 10(b)$$

$$\text{Case (c)} \quad \frac{X_o}{H} = 4n \cdot \frac{f_c}{f_t + f_c} \qquad 10(c)$$

The second general equation, equating the internal and external moments, reduces to:

$$\text{Case (b)} \quad \frac{M}{f_c} = \frac{BH^2}{6} \cdot n \cdot \left[6 - 7n + n \cdot \frac{f_t}{f_c}\right] \qquad 11(b)$$

$$\text{Case (c)} \quad \frac{M}{f_c} = \frac{BH^2}{6} \cdot 2n \cdot \left[3 - \frac{8n \cdot f_c}{f_t + f_c}\right] \qquad 11(c)$$

It is found that for case (a) the general equation cannot be reduced to a comparably simple form. Therefore, for this type of stress distribution, the moment taken by the section is found either by using the general equation directly, or alternatively by finding the load in each flange and its resultant line of application.

Pure Bending

Consider first the case of pure bending, which, as it applies to the design of spars for cantilever wings, is probably most frequently encountered at the present time.

Assuming the yield stress in compression $f_c = 5{,}000$ lb. per sq. in., and that the ultimate tension stress $f_t = 9{,}300$ lb. per sq. in., it is found that, when this maximum tension stress is reached, the stress distribution is of type (b) if n is less than 0.375, but of the type (a) if n is between 0.375 and 0.5. This may easily be checked by appropriate substitutions in equations 10(a) and 10(b). Calculation of the corresponding bending moments is carried out using equation 11 (b), or as described above for stress distribution of the type (a).

The apparent bending stress, M/Z, may thus be found, and is shown in Fig. 8, being the upper full line in that figure.

As previously described in relation to "plank" spars, a limit must be set for the compression strain. Assuming as before a maximum allowable strain-stress $f_c = 18{,}000$ lb. per sq. in., values of apparent bending stress are obtained corresponding to failure by excessive strain on the outer-

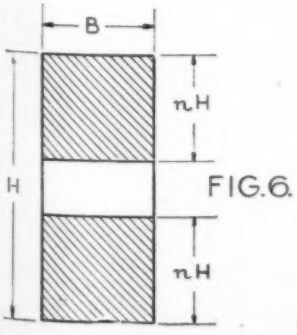
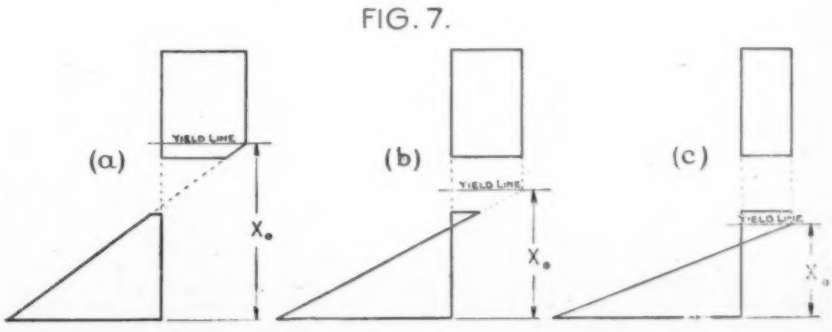
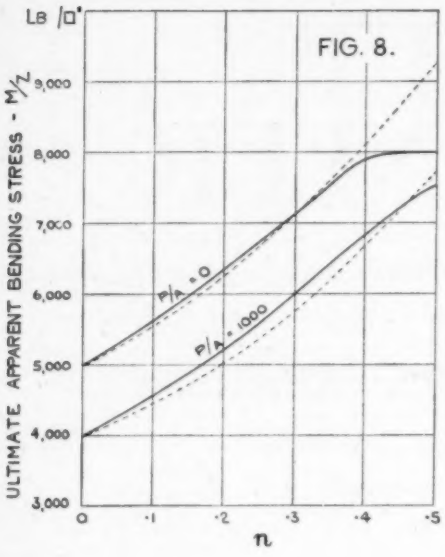
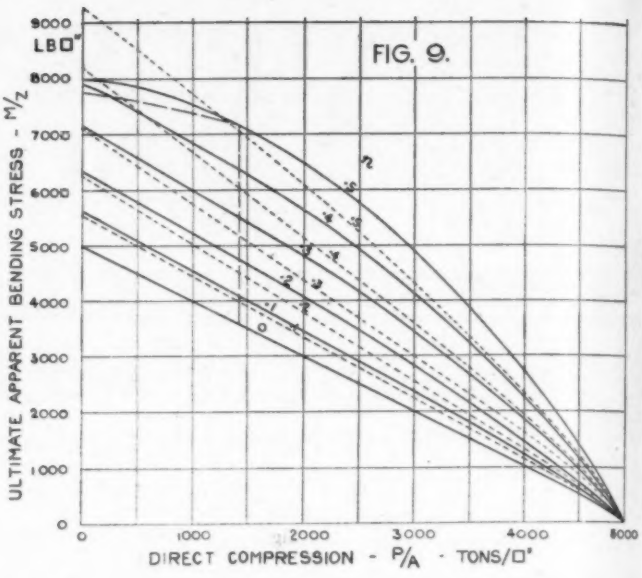


FIG. 6.

FIG. 7.







most compression fibres. These are indicated by the upper broken curve in Fig. 8. Thus, for any value of n, the allowable apparent bending stress is given by one of these two curves, *whichever is the lower.*

Combined Stresses

If the beam is under end load, as well as bending (as in the spars of a biplane or braced monoplane) then the above equations may be used, provided appropriate values of f_c and f_t are employed. The direct compressive stress being $f_p (= P/A)$, then

$$f_c = 5{,}000 - f_p \quad \ldots \quad (5)$$

and

$$f_t = 9{,}300 + f_p \quad \ldots \quad (6)$$

and the maximum allowable compression strain due to bending is defined by

$$f_c = 18{,}000 - f_p \quad \ldots \quad (8)$$

As an example, for $f_p = 1{,}000$ lb. per sq. in., the lower full and broken curves of Fig. 8 are obtained for tension and compression failure respectively.

It is noticed that, as the value of the direct compressive stress is increased, the stress distribution of type (b) applies (at failure due to tension) up to increasingly higher values of n; e.g. for $f_p = 1{,}000$ it applies up to $n = .468$ approximately, whilst for $f_p = 1{,}425$ lb. per sq. in. case (b) applies for all values of n, up to $n = 0.5$.

Curves for allowing bending stress (M/Z) against direct stress (P/A) are given in Fig. 9. The full lines apply to failure by tension, and the broken lines to failure by excessive compression strain. Curves for values of n intermediate between those shown may be interpolated by cross-plottings similar to Fig. 8.

Intermediate Sections

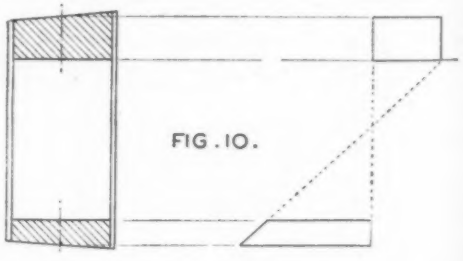
Spar sections such as a spindled plank, and box spars with heavy webs, may be considered as intermediate between the plank and the thin-web types. The area of web, or webs, may be taken into account in calculating the direct stress (P/A). If plywood webs are used, the total area should be appropriately reduced to allow for any plies in which the direction of grain does *not* lie *along* the spar. It would be safest to neglect such parts of the area altogether.

The value of n used should be that corresponding to the "flange" part of the spar. The allowable bending stress thus obtained may be multiplied by the section modulus (Z) for the *full* section (less any reduction for cross-plies). The allowable bending moment obtained in this way, whilst higher than would be obtained by neglecting the webs altogether, will still have an error, generally small, on the safe side.

Advantage may sometimes be taken of the greater strength of spruce in tension than in compression, by making the tension flange the smaller in area. For pure bending, maximum efficiency is obtained with the tension flange not less than half the area of the compression flange, the exact ratio depending upon the flange depth as a proportion of the total depth of the spar.

Limited Usefulness

Illustration, Fig. 10 shows such a spar, designed for optimum bending strength in one direction only. Its stress diagram at ultimate B.M. is also shown, indicating the conditions to be obtained: viz., with tension and compression areas equal, and the yield line coincident with



the inner edge of the compression flange, the maximum tension stress should equal the ultimate tensile stress of the material. The stress analysis of such a spar may be carried out on the lines indicated in this article, and will be found easy to treat *ab initio* provided (a) the webs may be neglected, and (b) the yield line falls between (and not within) the flanges.

It must be remembered that such a spar is only about half as strong in bending in the opposite direction, and its usefulness is limited accordingly.

Structural Steel and Aircraft Alloys

THE latest folder issued by Head, Wrightson and Co., Ltd., of Thornaby-on-Tees, gives data on the rods and hexagon couplings for structural steelwork.

Apart from their intensive production of steelwork as used in large aircraft hangars and factories, the company makes forgings and stampings in carbon and special alloy steels for the aircraft and other industries.

BALANCE CALCULATIONS

An Alternative Method to Those of Air Publications 970 and 1208 : Greater Simplicity Claimed

By W. WILSON

IN determining the loads for calculating the strength of an aircraft structure, especially the wing structure, it is necessary to carry out "balance calculations" for certain flight conditions (Refs. 1 and 2). The following procedure is usually adopted :—A diagram, to scale, is drawn for each case. Each known and unknown load is placed in its appropriate position. The moment arms about the centre of gravity are scaled off parallel and normal to the flight path. Balance equations can then be written, the solution of which give the unknown loads.

In no case is it possible, by the above method, to determine the loads for any particular case from a previous one. This is because every new case involves

(i) A fresh centre of pressure position on the wing.

(ii) A fresh datum line (i.e., the flight path) parallel and normal to which the moment arms are measured.

The present article attempts to simplify and save time on balance calculations by

(*a*) Abandoning the conception of a centre of pressure of load on the wing, but instead applying the wing load at the mean aerodynamic centre of the wing. This involves the introduction of a moment, i.e., the no lift moment.

(*b*) Using a fixed datum which has no reference to the flight path.

(*c*) Adopting a tabular method for the solution of the balance equations.

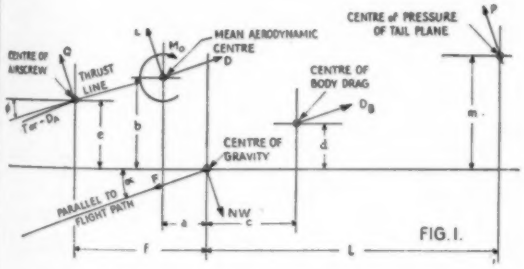


FIG. 1.

Fig. 1 shows a diagram of balance centres, which remain fixed for any flight condition. The known and unknown loads are applied at five centres, i.e. :

(1) The mean aerodynamic centre of the wing.
(2) The centre of gravity.
(3) The centre of body drag (extra to wing).
(4) The centre of airscrew.
(5) The centre of pressure of the tail plane.

The definition and methods of determining the mean aerodynamic centre were given in an article in the *Aircraft Engineer* (Ref. 3).

The centre of gravity and centre of resistance are determined by the usual method. The centre of the airscrew is obtained from a drawing of the aircraft. The centre of pressure of the tail plane is assumed to be at one-third the tail plane mean chord. All moment arms are measured parallel and normal to a convenient horizontal datum, e.g., the thrust line or the horizontal datum of the aircraft.

The notation used for the moment arms and loads follows that used in A.P. 970 and A.P. 1208 (the moment arms being now measured, however, parallel and normal to the horizontal datum chosen), with the following additions :—

M_0 = no lift moment on wing.
Q = component of thrust normal to flight path.
f = horizontal moment arm of centre of airscrew.
c = horizontal moment arm of centre of body drag.
m = vertical moment arm of centre of pressure of tail plane.

It should be noted that moment arms and loads are considered positive in sign as shown in Fig. 1, the reference lines for the moment arms being horizontal and vertical lines drawn through the centre of gravity.

Referring to Fig. 1 :—

$$Q = T \sin (\alpha - \phi)$$
$$= T (\alpha - \phi) \quad .. \quad .. \quad .. \quad .. \quad (1)$$

since the angle $\alpha - \phi$ will usually be small. In the case when the horizontal datum is parallel to the thrust line, $\phi = 0$

Resolving loads parallel to the flight path :—

$$F = D + D_B - T \quad .. \quad .. \quad .. \quad .. \quad (2)$$

Resolving loads normal to the flight path :—

$$NW = L + Q + P \quad .. \quad .. \quad .. \quad .. \quad (3)$$

or $$L = NW - Q - P \quad .. \quad .. \quad .. \quad .. \quad (4)$$

Taking moments about the centre of gravity :—

$$-T (e \cos \alpha + f \sin \alpha) + Q (f \cos \alpha - e \sin \alpha)$$
$$+ L (a \cos \alpha - b \sin \alpha) + D (b \cos \alpha + a \sin \alpha) + M_0$$
$$+ D_B (d \cos \alpha - c \sin \alpha) - P (l \cos \alpha + m \sin \alpha) = 0$$

In this equation, very little loss of accuracy will result by putting $\cos \alpha = 1$ and $\sin \alpha = \alpha$, since α will usually be small.

If the quantities in brackets (which are the "resultant" moment arms obtained by scaling off a diagram by the usual method) are therefore written

$$e_1 = e + f\alpha$$
$$f_1 = f - e\alpha$$
$$a_1 = a - b\alpha$$
$$b_1 = b + a\alpha$$
$$d_1 = d - c\alpha$$
$$l_1 = l + m\alpha$$

the equation becomes

$$-Te_1 + Qf_1 + La_1 + Db_1 + M_0 + D_B d_1 - Pl_1 = 0 \quad (5)$$

from which

$$P = -T\frac{e_1}{l_1} + Q\frac{f_1}{l_1} + L\frac{a_1}{l_1} + D\frac{b_1}{l_1} + M_0\frac{1}{l_1} + D_B\frac{d_1}{l_1} \quad .. \quad (6)$$

Equation (6) is used in conjunction with equation (3) when NW is unknown (e.g., gust cases).

Substituting for L in equation (5) from equation (4) :—

$$-Te_1 + Q(f_1 - a_1) + NWa_1 + Db_1 + M_0 + D_B d_1 - P(l_1 + a_1) = 0$$

From which

$$P = -T\frac{e_1}{l_1 + a_1} + Q\frac{f_1 - a_1}{l_1 + a_1} + NW\frac{a_1}{l_1 + a_1} + D\frac{b_1}{l_1 + a_1} + M_0\frac{1}{l_1 + a_1} + D_B\frac{d_1}{l_1 + a_1} \quad .. \quad (7)$$

Equation (7) is used in conjunction with equation (4) when L is unknown (e.g., level flight and glide cases).

In the above equations for engines-off cases, $-D_A$ is substituted for T and Q = 0.

The application of the method is shown by the following example :—The following data refer to a normal category, twin-engined aircraft for passenger transport, designed to civil requirements. It should be emphasised that these data are purely imaginary and refer to no particular aeroplane.

All up weight	=	20,000 pounds.
Stalling speed	=	75 miles per hour
Normal top speed	=	180 miles per hour. I.A.S. at 10,000 ft. ($\sqrt{\sigma}$ = .86)
Wing area	=	1,000 sq. ft.

Mean equivalent chord = 12 ft.
Body drag = 180 pounds at 100 miles per hour.
Airscrew drag (2 airscrews) = 530 pounds at 100 miles per hour.
Speed of fast glide for which L/D = 2.58 = 270 miles per hour I.A.S.

Initial setting of no lift line of wing = + 2.5° to thrust line.

Fig. 2 shows the diagram of balance centres, the moment arms being given parallel and normal to the thrust line

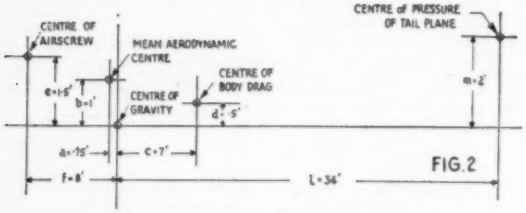


FIG. 2

which is parallel to the aircraft datum line.

Fig. 3 shows, plotted against C_L, curves of C_L/C_D (wing alone), overall L/D for engines on flight, overall L/D for engines off or gliding flight and α_0 (where α_0 = angle of incidence from no lift line of wing).

Fig. 4 shows the thrust horse-power required curve.

Table I gives the calculations of the data required for the balance calculations.

Table II gives the solution, in tabular form, of the balance equations.

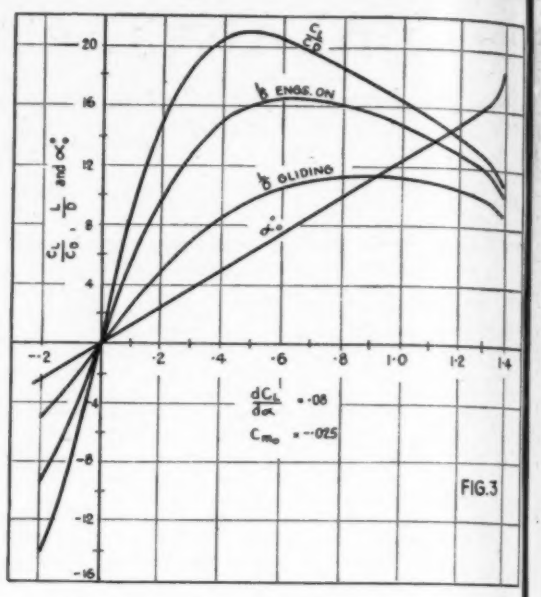


FIG. 3

∴ Resultant speed $= \sqrt{V^2 + U^2}$
$= \sqrt{180^2 + 14.7^2} = 181$ miles per hour.

Line 7.—For gust cases, C_L is obtained from values of α_0 (line 8) using α_0 curve (Fig. 3) or $C_L = .08\ \alpha_0$

TABLE I.

			Gust Cases.	Level Flight Cases.	Fast Glide Case.	Up Gust.	Down Gust.	C.P. Forward Engs. on.	C.P. Forward Engs. off.	C.P. Back Engs. off.	Fast Glide.
1	N	—	—	—	—	2.0	2.0	5.0	5.0	3.75	2.0
2	NW	lb.	—	—	·933 NW	Unknown	Unknown	100,000	100,000	75,000	37,300
3	V	M.P.H.	—	—	—	181	181	75	75	180	270
4	$V\sqrt{\frac{N}{2}}$	M.P.H.	—	—	—	181	181	118.5	118.5	247	270
5	V^2	—	—	—	—	32,800	32,800	5,630	5,630	32,400	72,900
6	NV^2	—	—	—	—	65,600	65,600	28,150	28,150	121,500	145,800
7	C_L	—	$.08\alpha_0$	$\frac{7820}{V^2}$	$\frac{7290}{V^2}$	.614	−.132	1.39	1.39	.242	.100
8	$\alpha_0°$	—	α_0°C.P.B.±4.67°	$\frac{C_L}{.08}$		7.69	−1.65	18.6	18.6	3.02	1.25
9	L	lb.	$2.46\ C_L NV^2$	—	—	103,000	−22,200	Unknown	Unknown	Unknown	Unknown
10	$\frac{C_L}{C_D}$	—	—	—	—	20.4	−10.4	11.0	11.0	16.9	9.0
11	D	lb.	$L/\frac{C_L}{C_D}$	$NW/\frac{C_L}{C_D}$		5,050	2,130	9,100	9,100	4,430	4,150
12	D_F	lb.	$\frac{180}{10,000} \times NV^2$			1,180	1,180	505	505	2,200	2,020
13	D_A	lb.	$\frac{530}{10,000} \times NV^2$			0	0	0	1,490	6,480	7,720
14	T.H.P.	—	—	—	—	865	865	388	0	0	0
15	T	lb.	$\frac{750 \times \text{T.H.P.}}{V\sqrt{N/2}}$			3,600	3,600	2,460	0	0	0
16	M_0	ft. lb.	$-.768\ NV^2$	$-.768\ NV^2$ / $-.878\ NV^2$	$-.768\ NV$	−50,400	−50,400	−21,400	−21,400	−107,100	−111,800
17	α^1	—	$\alpha_0° - 2.5°$			5.19	−4.15	16.1	16.1	.32	−1.25

The following explanations are given of Table I:—

Line 1.—The values of load factor N are taken from A.P. 1208.

Line 2.—For fast glide, NW is considered to be the resolved part of NW normal to the flight path (F being the resolved part of NW parallel to the flight path).

Angle of glide, $\theta = \tan^{-1}\frac{1}{2.58} = 21.2°$

∴ $NW = NW \cos\theta = .933\ NW$

Line 3.—For gust cases, speed of vertical gust:

$$U = 25 \times \frac{60}{88} \times \sqrt{\sigma} = 25 \times \frac{60}{88} \times .86$$
$$= 14.7 \text{ miles per hour at 10,000 ft.}$$

For level flight cases:

$$C_L = \frac{W \times 391}{SV^2} = \frac{20,000 \times 391}{1,000 \times V^2} = \frac{7820}{V^2}$$

For fast glide case:

$$C_L = \frac{W \times 391}{SV^2} \cos\theta = \frac{7820}{V^2} \times .933 = \frac{7290}{V^2}$$

Line 8.—For gust cases, change of incidence due to gust:

$$\pm \tan^{-1}\frac{U}{V} = \pm \tan^{-1}\frac{14.7}{180} = \pm 4.67°$$

∴ $\alpha_0 = \alpha_0$ for C.P. Back case $\pm 4.67°$

For level flight and fast glide cases, α_0 is obtained from values of C_L (line 7) using α_0 curve (Fig. 3) or $\alpha_0 = \frac{C_L}{.08}$

Line 9.—For gust cases

$$L = \frac{C_L S N V^2}{391} = \frac{C_L \times 1000 \times NV_2}{391} = 2.56\, C_L N V^2$$

Line 10.—Values obtained from C_L/C_D curve (Fig. 3).

Line 11.—For gust cases

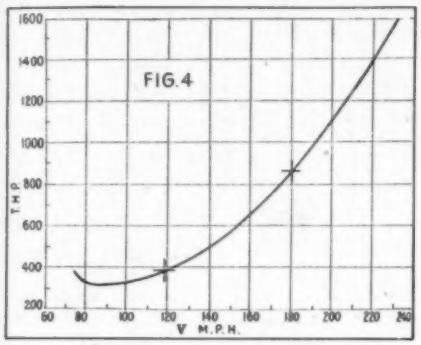
$$D = L \Big/ \frac{C_L}{C_D}$$

For level flight and fast glide cases

$$D = NW \Big/ \frac{C_L}{C_D}$$

Line 12.—

D_B = 180 pounds at 100 miles per hour.



$$\therefore \quad D_B = \frac{180}{10{,}000} \times NV^2$$

Line 13.—

D_A = 530 pounds at 100 miles per hour.

$$\therefore \quad D_A = \frac{530}{10{,}000} \times NV^2$$

Line 14.—Values of T.H.P. corresponding to the "factored" speed ($V\sqrt{\frac{N}{2}}$) are read off from Fig 4.

Note.—"Factored" speed for gust cases = normal top speed = 180 miles per hour.

Line 15.—

$$T = 2 \times \frac{375 \times \text{T.H.P.}}{V\sqrt{N/2}} = \frac{750\ \text{T.H.P.}}{V\sqrt{N/2}}$$

See note under Line 14 for gust cases.

Line 16.—For all cases except C.P. Back

$$M_0 = \frac{C_{mo} c S N V^2}{391} = \frac{-.025 \times 12 \times 1000 \times NV^2}{391}$$

$$= -.768\, NV^2$$

For C.P. Back an artificial increase of C_{mo} may be necessary to comply with the condition that the centre of pressure for this case must be 10 per cent. of the mean chord farther aft than the centre of pressure for C.P. Forward.

The artificial value is given by

$$C_{mo} = \frac{C_L\, C_{mo}}{C_{L\max.}} + \frac{C_L}{10}$$

Where C_L = lift coefficient for C.P. Back.

$C_{L\max}$ = lift coefficient for C.P. Forward.

Hence for C.P. Back

$$C_{mo} = -\left(\frac{.242 \times .025}{1.39} + \frac{.242}{10}\right)$$

$$= -(.00435 + .0242) = -.02855$$

$$\therefore \quad M_0 = -\frac{.02855}{.025} \times .768\, NV^2 = -.878\, NV^2$$

Line 17.—Due to initial wing setting

$$\alpha = \alpha_0 - 2.5^\circ$$

The following explanations are given of Table II.

Line 1.—For gust cases the values of NW are obtained by solving equation (3).

Line 2.—For level flight and fast glide cases, the values of L are obtained by solving equation (4).

Lines 3 *to* 8.—Values are obtained from Table I.

Line 10.—Q is obtained by solving equation (1) ($\phi = 0$).

Line 11.—F is obtained by solving equation (2).

Lines 13 *to* 20.—These give the calculation of the "resultant" moment arms as given in equations (6) and (7).

Lines 21 *to* 27.—For gust cases these represent the solution of equation (6), for level flight and fast glide cases the solution of equation (7).

It should be noted that, to comply with modern notation, the coefficients C_L, C_D, etc., are used in place of K_L, K_D, etc.; also that speeds are expressed in miles per hour with constants appropriately modified.

In conclusion, it has been proved by experience that the present method gives a considerable saving of time over the old one and is definitely worth while if two or more cases have to be considered, which is usually so. Moreover, by the use of tabulation in the present method, the balance calculations are much more compact and it is possible to carry out modifications more easily as compared with the old method.

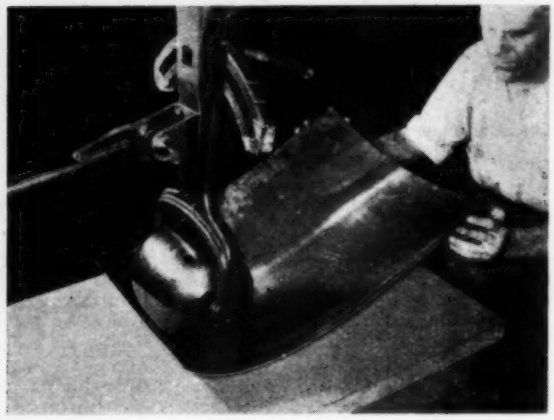
TABLE II.

				Up Gust.	Down Gust.	C.P. Forward Engs. on.	C.P. Forward Engs. off.	C.P. Back Engs. off.	Fast Glide.
1	NW	lb.	L + Q + P	103,834	−24,595	100,000	100,000	75,000	37,300
2	L	lb.	NW − Q − P	103,000	−22,200	98,406	98,817	76,030	35,352
3	D	lb.	—	5,050	2,130	9,100	9,100	4,430	4,150
4	D_B	lb.	—	1,180	1,180	505	505	2,200	2,620
5	D_A	lb.	—	0	0	0	1,490	6,480	7,720
6	T	lb.	—	3,600	3,600	2,460	0	0	0
7	M_0	ft. lb	—	−50,400	−50,490	−21,400	−21,400	−107,100	−111,800
8	α	—	—	5.19	−4.15	16.1	16.1	.52	−1.25
9	a	rad.	α°/57.3	.091	−.073	.28	.28	.0091	−.021
10	Q	lb.	Ta	345	−276	690	0	0	0
11	F	lb.	D+D_B−T(+D_A)	2,440	−480	7,145	11,105	13,110	14,490
			e = 1.5 ft. c = 7.0 ft.	f = 8.0 ft. d = .5 ft.		a = .75 ft. l = 34.0 ft.		b = 1.0 ft. m = 2.0 ft.	
13	e_1	ft.	$e + fa$	2.226	.916	3.740	3.740	1.573	1.332
14	f_1	ft.	$f - ca$	7.864	8.109	7.580	7.580	7.986	8.032
15	a_1	ft.	$a - ba$	.659	.823	.470	.470	.741	.771
16	b_1	ft.	$b + aa$	1.069	.945	1.210	1.210	1.007	.981
17	d_1	ft.	$d - ca$	−.137	.551	−1.460	−1.460	.436	.515
18	l_1	ft.	$l + ma$	34.182	33.854	34.560	34.560	34.018	33.958
19	$l_1 + a_1$	ft.	—	34.841	34.667	35.030	35.030	34.759	34.729
20	$l_1 - a_1$	ft.	—	7.205	7.286	7.110	7.110	7.245	7.261
	NW Unknown L Unknown								
21	$-T\frac{e_1}{l_1}$		$-T(+D_A)\frac{e_1}{l_1+a_1}$	−234	−97	−260	159	294	296
22	$Q\frac{f_1}{l_1}$		$Q\frac{f_1 - a_1}{l_1 + a_1}$	80	−66	140	0	0	0
23	$L\frac{a_1}{l_1}$		$NW\frac{a_1}{l_1 + a_1}$	1,985	−539	1,340	1,340	1,600	829
24	$D\frac{b_1}{l_1}$		$D\frac{b_1}{l_1 + a_1}$	158	60	315	315	128	118
25	$M_0\frac{1}{l_1}$		$M_0\frac{1}{l_1 + a_1}$	−1,475	−1,490	−610	−610	−3,080	−3,230
26	$D_B\frac{d_1}{l_1}$		$D_B\frac{d_1}{l_1 + a_1}$	−5	19	−21	−21	28	30
27	P	lb.	P lb.	509	−2,113	904	1,183	−1,030	−1,948

Ref. 1. A.P. 1208.

Ref. 2. A.P. 970.

Ref. 3. *Aircraft Engineer*, April 30th, 1936: "Mean Aerodynamic Centre and Chord," by J. R. Crean, S.Sc.

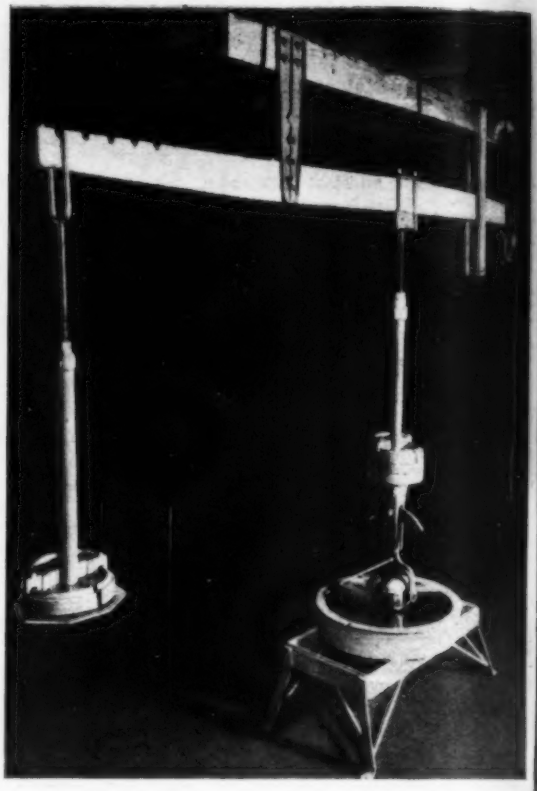


THE MODERN WAY

A Sheet-forming Tool with Many Applications

ALTHOUGH the tendency in present-day aircraft construction is so to design the shapes of major members that panel beating is avoided (in other words, to employ what, some years ago, Mr. H. J. Pollard termed "developable surfaces"), there are inevitably certain sheet-metal parts which must of necessity be given a double curvature, such as wing fillets, engine nacelles, and undercarriage fairings.

An ingenious tool for forming rapidly and accurately such parts in sheet metal was introduced into this country some time ago from America, where it has attained considerable popularity. Known as the Northill-Carter crowning machine, the tool consists basically of a set of interchangeable hard-metal rollers with their corresponding female forms, the rollers being supported on a "whipple tree" arrangement either from the ceiling of the shop or from a horizontal beam fastened to some convenient stanchion. The pressure of the roller on the job is adjusted, for the different materials and gauges to be formed, by split weights suspended from the oscillating arm of the machine.



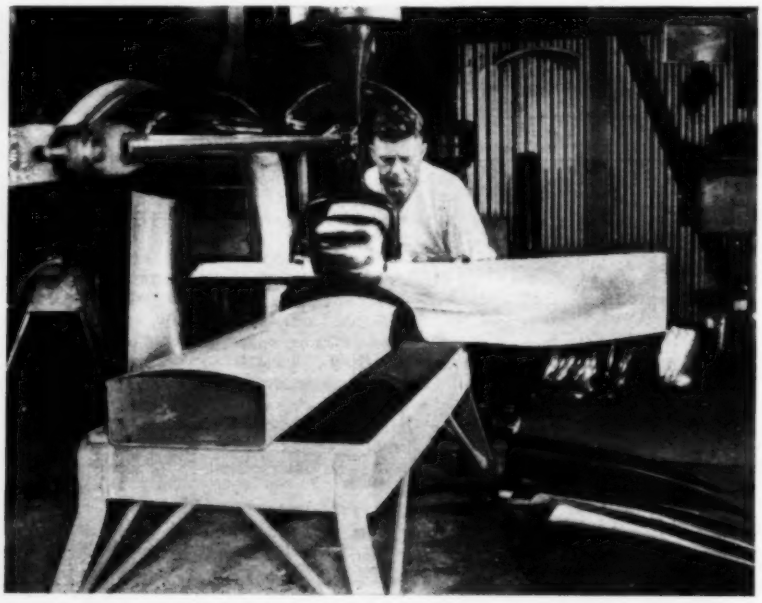
The Northill-Carter crowning machine. The hard-metal roller is suspended from an oscillating arm and pulled to and fro by the operator. On the left, above, a sheet is being formed by the power-operated model.

Normally the Carter crowning machine is hand operated, but where large quantities have to de dealt with an electric motor attachment is available.

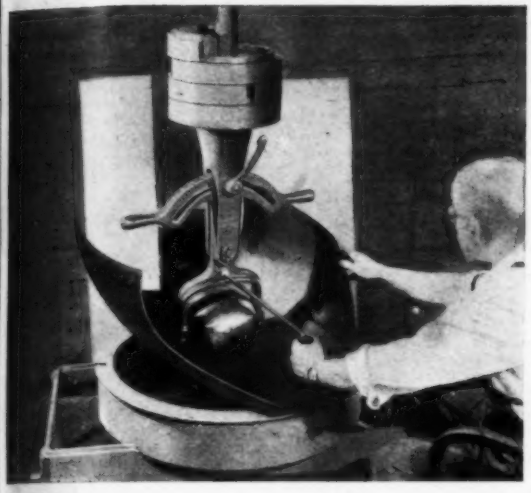
Forming is accomplished by the operator pulling and pushing the metal roller to and fro, and the roller support has an adjustment for lateral tilt so that pressure on one side can be made greater than on the other, or curvatures of different radii obtained with a given roller. The force required to operate the crowning machine is not great, but obviously the use of the power-driven model leaves the operator with both hands free to move the job about.

Supplied with the machine are two highly polished hard-metal rollers of different shape, a highly polished hard-metal bowl 32in. in diameter and 2in. deep, a face plate measuring 24in. by 48in., having one surface of smooth laminated maple and the other of highly polished hard metal, a reverse-curve form 18in. by 48in., and a welded steel table and bowl support.

It goes without saying that some experience is needed before the operator gets the knack of working the machine to best advantage, but once this knack has been acquired the work proceeds rapidly.



A wing fillet being formed. It is claimed that the operation, from rough, can be accomplished in 30 minutes.



A typical deep crowning operation. The material in this case is stainless steel.

Roughing-out is accomplished by placing the work on a felt or rubber pad in the concave bowl and oscillating the roller to and fro. The finishing operations will depend upon the nature of the job, but an advantage of the machine is that it leaves the original mill finish of the sheet unimpaired. From the point of view of strength, the great advantage of the Carter crowning machine is that it shrinks as well as stretches the material, so that the finished article is of uniform thickness, without tool marks.

Among British aircraft constructors who have installed the Carter crowning machine are Handley Page, Ltd., and the Gloster Aircraft Co., Ltd. We believe that the machine is giving good service in both works.

The Northill Company, Inc., of Los Angeles, California, also manufacture an ingenious square shearing machine which should be more rapid than the ordinary "nibbler," and can produce almost as intricate shapes, so long as no curves are required.

Agents for the Northill-Carter crowning machine are Millar Aviation, Ltd., of 28, Bolton Street, London, W.1, from whom further particulars may be obtained.

TECHNICAL LITERATURE

SUMMARIES OF A.R.C. REPORTS

REPORTS published by His Majesty's Stationery Office, London, which may be purchased directly from H.M. Stationery Office at the following addresses: Adastral House, Kingsway, W.C.2; 120, George Street, Edinburgh; York Street, Manchester, 1; St. Andrew's Crescent, Cardiff; 15, Donegall Square West, Belfast; or through booksellers.

EFFECT OF DIFFERENCES OF FORM ON THE PORPOISING CHARACTERISTICS OF TWO FLYING BOATS. By L. Johnston, B.Sc., and W. D. Tye. Communicated by the Director of Scientific Research, Air Ministry. R & M. No 1777. (10 pages and 11 diagrams.) October 23, 1936. Price 1s. 6d. net.

Service trials of a four-engined flying boat with hull form "A" showed that it had a tendency to porpoise when trimmed back or landed slowly. An extensive series of tank tests were made in order to eliminate this, and in the process many modifications were tried. The final result was hull form "B," which was a complete success full scale.

The tests on the various modified forms lead to the conclusion that form "B" was more stable when planing than form "A" chiefly because the upper limiting attitude for stability was raised by 3° to 4°. This was due to (a) pointed main step, (b) equivalent straight step being farther aft, and (c) less effective afterbody by virtue of (i) narrower beam at rear step, (ii) greater angle of dead-rise in cross-sections, and (iii) straight keel line aft without hook.

The lower limit was adversely affected by (a) and (b) above, but the larger forebody and greater wing setting had a beneficial effect. The net result was that the lower limits almost coincided. The free-to-trim attitude of form "B" with tail plane neutral was about mid-way between the stability limits, thus allowing the aircraft to be trimmed a fair amount without risk of porpoising. In form "A" the free-to-trim attitude was very close to the upper limiting angle for stability.

NOTE ON THE STANDARDISATION OF PITOT-STATIC HEAD POSITION ON MONOPLANES. By S. B. Gates, M.A., and J. Cohen, B.A., B.Sc. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No 1778. (14 pages and 8 diagrams.) January 6, 1937. Price 2s. net.

With the development of the clean monoplane it becomes important to standardise a position of the pitot-static head which will give a reasonably small speed error without affecting seriously the performance or maintenance of the aircraft. This position should be such that (a) the local speed should not differ from the true speed, over the incidence range, by more than a certain amount. The amount is debatable, and may vary for different classes of aircraft. To fix ideas, suppose that the local speed must always be within ±5 per cent. of the true speed*; (b) the variation with incidence of the inclination of the local velocity should not be such as to introduce a large error in the reading; (c) the recorded speed should not be seriously affected by alteration in the wing profile, e.g., movement of flaps; (d) the drag of the supporting structure should be small, and the pressure head not liable to damage caused by an exposed position.

* Alternatively it may be argued that a small *variation* of error with incidence, about a mean error of any size, would be equally satisfactory. If, however, the instrument purports to read the local speed it seems that a small variation in error is linked with a small mean error. As the present discussion is confined to measurements of this kind the form of the analysis, although arbitrary, has something to recommend it, in addition to the fact that it is suitable to the material available.

Of these, (b) and (c) are not difficult to satisfy. The problem lies in making a compromise between (a) and (d), since the error decreases and drag and maintenance difficulty increase as the head is moved away from the wing. The problem has not been studied systematically, and the object of this note is to collect such information as bears on its solution.

A survey of the velocity field round aerofoils indicates that it may be possible to use either of two wedge-shaped regions in which the velocity error is less than ± per cent.; one extends forward of the aerofoil from near its nose and the other backwards from a point above the trailing edge. The forward position would give a low drag installation, but the evidence suggests that the head must be at least 0.4c in front of the nose. Velocity conditions are not so critical in the rear position but its use would need careful design for low drag. The under surface position which is much used at present, satisfies the 5 per cent. error limit only when the lower surface is convex, and in this case the error usually exceeds 5 per cent. near the stall. This position has, however, certain compensating advantages. It is suggested that the spanwise position should be halfway between the end of the flap and the wing tip, but not nearer to the tip than 0.2 of the semi-span.

Standardisation to an error limit of 5 m.p.h. at speeds exceeding 300 m.p.h. is impossible on the information available; but this problem can conveniently be attacked by *ad hoc* model tests of new designs.

CALCULATED FLEXURAL-TORSIONAL FLUTTER CHARACTERISTICS OF SOME TYPICAL CANTILEVER WINGS. By W. J. Duncan, D.Sc., A.M.I.Mech.E., F.R.Ae.S., and H. M. Lyon, M.A., A.F.R.Ae.S. R. & M. No. 1782. (32 pages and 21 diagrams.) April 1, 1937. Price 4s. 6d. net.

As an aid to the prediction of flexural-torsional critical flutter speeds, the influence of wing, stiffness, density, separation of the flexural and inertia axes, and structural damping on the critical conditions for a typical cantilever wing have been investigated.

The more important conclusions are :—(i) in almost all cases reduction of flexural stiffness raises the critical speed; (ii) the critical speed rises rapidly as the condition of mass balance is approached; (iii) the influence of structural damping on the critical speed is not very marked unless the wing is nearly mass balanced or the wing density very low, (iv) the Küssner coefficient rises rapidly as the condition of mass balance is approached; (v) it follows from reasonable assumption that the critical flutter speeds of similar wings of constant chord vary inversely as the span.

The calculations show that the critical speed for flexural-torsional flutter usually rises when the flexural wing stiffness is reduced, while the torsional stiffness remains constant. This might be construed as an argument in favour of low flexural stiffness, and the authors point out that low flexural stiffness may be associated with a low flutter speed unless completely effective measures have been taken to prevent the ailerons from participating in the flutter.

The correctness of the numerical results embodied in the curves depends on the values of the aerodynamical coefficients adopted in the calculations. These values are based on such slight experimental evidence that they are certainly not beyond suspicion. No satisfactory theory for the calculation of the coefficients yet exists so far as the authors are aware. Theoretical values have been found for the case of infinite aspect ratio, but there is little justification for applying these to finite wings.

NOTE ON THE WHIRLING OF RADIAL ENGINES ON THEIR MOUNTINGS: MATHEMATICAL ANALYSIS AND EXPERIMENTAL OBSERVATIONS. By B. C. Carter, F.R.Ae.S. R. & M. No. 1783. (25 pages and 11 diagrams.) October 16, 1935. Price 3s. 6d.

An important practical method of reducing aircraft vibration is to mount the power plant in an appropriate manner as regards elastic constraints. The mathematical analysis given in this report has been made to serve as a basis for solving some of the problems that arise in this connection. The analysis also concerns the possibilities of damage to engines and airscrews from whirling vibration, whether on the test bed or in aircraft, and it forms a basis for vibrograph investigation of corresponding movement of the engine.

Part I is a general statement of the system considered and the simplifying assumptions made. Part II is a mathematical examination of whirling vibration caused by the airscrew being out-of-track. Part III is a mathematical examination of whirling vibration caused by the airscrew being statically unbalanced. Part IV gives the results of experimental observations.

The general outcome of the experimental observations is that the theory presented in Parts II and III is, in reasonable agreement, but, actually, there is important flexibility within the system itself, and complete treatment would take account of this explicitly.

When the airscrew has more than two blades there are two critical whirling speeds and their values are affected by gyroscopic action of the airscrew. An important general inference is that for engines mounted in the manner considered, the whirling vibration caused by airscrew out-of-track is very similar to that caused by airscrew unbalance; in particular instances it is the same, and then there is a simple formula which expresses equivalent unbalance and out-of-track as regards effectiveness in producing whirling vibration

THE AIRCRAFT ENGINEER

TESTS OF THE N.A.C.A. II-A MODEL HULL IN THE R.A.E. SEAPLANE TANK. By L. P. Coombes, B.Sc., and F. G. Brown. R. & M. No. 1784. (12 pages and 4 diagrams.) September 23, 1936. Price 2s. net.

An exchange of models was arranged with the N.A.C.A. Tank at Langley Field in order that the results obtained in the two tanks might be compared. As the American model was large for the R.A.E. Tank, the tests also served as a check on the results of the tank calibration made previously. This report describes the tests of the American model, the N.A.C.A. 11-A hull.

Measurements of drag, moment and depth of immersion were made at four angles and several different loads. The range covered was considered to be sufficiently wide to make a reliable comparison possible.

The difference between the R.A.E. and N.A.C.A. results, based on mean values, was generally very much less than 5 per cent. for drag and 7½ per cent. for moment measurements. The agreement is considered satisfactory, and can be accounted for by experimental errors and the like. No evidence of wall interference or depth effect was found, and the conclusions of the tank calibration tests were thus supported.

COMPARISON OF RESULTS OF TESTS OF THE SINGAPORE II.c MODEL HULL IN FIVE TANKS. By J. P. Gott, Ph.D. R. & M. No. 1785. (16 pages and 18 diagrams.) November 26, 1936. Price 2s. 6d. net.

Models of the Singapore II.c hull have been tested in five tanks, and, although the tests were not always intended to be comparative, the results have been collected and examined to find what measure of agreement exists among the results of different tanks. The five series of tests are as follows :—

A 1/16th scale model was tested in three tanks :—

1. The Yarrow tank at the National Physical Laboratory.
2. The tank of the designers, Messrs. Short Bros., at Rochester.
3. The Canadian tank at Ottawa.
4. Models of 1/18th, 1/12th, 1/6th scale were tested in the R.A.E. Tank.

These tests were for the purpose of tank calibration and covered only a very limited range of loads and attitudes.

5. A 1/12th scale model has recently been tested in the N.A.C.A. tank at Langley Field. This model is the 1/12th scale model used in the R.A.E. tests in series 4.

Comparison of the drag measurements in various tanks shows general agreement, but the detail differences are considerable. These differences are probably due to differences in technique, to experimental error and to the use of several models. Comparison of the pitching moments measured in three tanks shows systematic differences of the order of 10 per cent. to 20 per cent. These differences have not been explained. Recent experience suggests that any future comparisons should be made on models 6 or 7 feet long.

A REVIEW OF THEORETICAL INVESTIGATIONS OF THE AERODYNAMICAL FORCES ON A WING IN NON-UNIFORM MOTION. By H. M. Lyon, M.A., A.F.R.Ae.S. R. & M. No. 1786. (33 pages and 8 diagrams.) April 12, 1937. Price 4s. 6d.

An investigation of published work on the application of aerodynamical theory to problems of non-uniform motion was undertaken as a preliminary step in an attempt to develop a method for the calculation of the aerodynamical derivatives of flutter theory for a finite wing. A review of the papers consulted in the course of this investigation is presented in this report.

The theory of the steady motion of thin aerofoils is briefly explained in the introductory paragraphs, and special attention is paid to methods of investigation which are applicable to cases of non-uniform motion. Two distinct methods of calculating the effect of the wake on the lift of a wing of infinite span in non-uniform motion are described, and the development of each method is traced through the work of various investigators. In conclusion the application of the results to the calculation of the aerodynamical derivatives of flutter theory is discussed.

ESTIMATION OF INCREASE IN LIFT DUE TO SLIPSTREAM. By R. Smelt, B.A., and H Davies, M.Sc. R. & M. No 1788. (20 pages and 16 diagrams.) February 3, 1937. Price 3s. net.

This report gives a method of calculating the increase in the lift coefficient of a wing due to the mounting of airscrews ahead of the leading edge. Distribution of velocity in the straight and inclined slipstreams behind an airscrew in the absence of a wing is first obtained, the effect of this velocity distribution on wing lift is then found by considering two extreme conditions, viz., slipstream width ÷ wing chord (1) very large and (2) very small. The formulæ thus obtained are checked by comparison with experimental results on several combinations of wing and airscrews, with and without engine nacelles and fuselage.

Comparison with experiment indicates that with any conventional arrangement of airscrews and wing it is possible, by means of the formulæ derived, to give an estimate of the lift coefficient during take-off and climb, provided that flaps are not fitted to the wing.

TESTS OF RIVETS AND BACKWARD-LAPPED JOINTS IN THE COMPRESSED-AIR TUNNEL By D H. Williams, B.Sc., A.F.R.Ae.S., and A. F. Brown, B.Sc. R. & M. No. 1789. (6 pages and 6 diagrams.) May 22, 1937. Price 1s 3d net.

An aerofoil, of section N.A.C.A. 0012, was tested over a range of Reynolds number up to $R = 8 \times 10^6$, with 7, 8 and 12 rows of rivets, and with 4 backward-lapped joints, on each surface.

The effect of 8 rows of rivets was to increase C_D min. of the smooth aerofoil by about 0.0007 over the whole range, the 7 rows gave the same increase up to $R = 2 \times 10^6$, but the effect was less at higher Reynolds numbers; the 12 rows increased C_D min. considerably over the middle part of the range, but the effect decreases at high values of R. The lapped joints increased C_D min. by about 0.0012 over the whole range.

The lapped joints have no effect on C_L max.; the 7 and 8 rows of rivets have little effect at high Reynolds numbers; the 12 rows have little effect at $R = 4 \times 10^6$ but the maximum lift falls rapidly for higher values of R.

THE INFLUENCE OF END CONSTRAINT ON THE TORSIONAL STIFFNESS OF A RECTANGULAR SECTION TUBE. By J. C. K. Shipp, B.Sc. R. & M. No. 1790. (7 pages and 4 diagrams.) March 22, 1937. Price 1s. 3d. net.

In calculating the torsional stiffness of a metal or plywood covered wing it is customary to employ Batho's formula in conjunction with an empirically determined *effective* value of the skin modulus of rigidity. By using an effective modulus instead of that appropriate to the skin material, some allowance is made for the fact that the actual wing conditions differ in a number of ways from those assumed in the derivation of Batho's formula. In practice, for example, tension fields may form in the skin material in contradistinction to the uniform shear conditions assumed by Batho, or the wing root section may be subject to axial constraint instead of being free to warp. This report is concerned with the latter kind of departure from the Batho conditions, and describes the results of calculations on the effect of end constraint on the torsional stiffness of a rectangular section tube representative of a monocoque wing structure.

For a metal tube with proportions representative of wing construction the increase of torsional stiffness due to end constraint, when measured at a section in the outer third of the tube length, is of the order of 10 per cent. For a wooden tube this increase rises to roughly 25 per cent. For short wide tubes, however, and for torques applied near the wing root, this increase in stiffness may be much greater.

THE DEVELOPMENT OF A HIGH-SPEED INDUCED WIND TUNNEL OF RECTANGULAR CROSS-SECTION. By A. Bailey, M.Sc., A.M.Inst.C.E., and S. A. Wood, M.Sc. R. & M. No. 1791. (16 pages and 8 diagrams.) February 23, 1937. Price 2s. 6d. net.

Experiments have been made on the N.P.L. high-speed jet to find out whether a satisfactory design of high-speed tunnel, to run from the C.A.T. exhaust and to measure 3 ft. × 1 ft., can be found. A wind tunnel was constructed with a working portion 6 in. × 3 in. in cross-section and 6 in. long, which was subsequently lengthened to 9 in. The design was based on experience with previous circular tunnels, the high-pressure ejector nozzle being in the form of a slot, of plain convergent profile, surrounding the tunnel downstream of the working portion.

The experiments made included modifications of the inlet flare and of the divergence of the working portion, and the determination of the effect of variations in the pressure on the ejector nozzle. These first tests were made without a model in the tunnel. Experiments were also made, with model aerofoils of thickness 0.24 in., 0.125 in. and 0.07 in. respectively in position, and the effect of modifying the longitudinal profile of the working section, to compensate for the presence of the model, was investigated by the use of liners.

Working speeds up to the local speed of sound can be obtained by the induced principle in a rectangular wind tunnel having a suitable divergence, with no model in position. The longitudinal variation of speed can be controlled by varying the divergence of one opposite pair of sides, and the lateral variation of speed is very small.

The introduction of a model aerofoil reduces the maximum value of u/a obtainable, the reduction increasing as the projected area of the model increases. With a projected model area 1/25 that of the tunnel, the maximum approach speed is 0.77a, and with a projected area 1/86 that of the tunnel, the speed is 0.85a. The rise in air speed downstream of the model, which occurs with a parallel tunnel, can be obviated by suitable modification of the profile of the walls parallel to the aerofoil.

The maximum air speed attainable can be slightly increased by lining down the working section, but the increase is limited by the relative increase in the projected area of the model.

In view of the likelihood that a different tunnel profile will be required for each different thickness of aerofoil and working speed, it is suggested that it would be convenient to use flexible walls on the sides of the tunnel parallel to the axis of the aerofoil. This would also enable the working speed to be controlled by means of a variable throat, downstream of the working section, where the speed would always be that of sound. Experience indicates that such an arrangement would result in more stable conditions than if the speed were controlled by varying the pressure on the ejector.

NOTE ON THE DRAG OF A GAUNTLET AS MEASURED IN THE 24 FT. TUNNEL. By W. G. Jennings, B.Sc. R. & M. No. 1792. (8 pages and 3 diagrams.) March 23, 1936. Price 1s. 6d.

The Gauntlet was, at the time of its introduction, representative of the best modern practice Service type aircraft design, and its measured performance exceeded expectations. Drag tests have been made on the actual aeroplane in the R.A.E. 24 ft. tunnel to investigate whether the high performance could be attributed to some particular feature in the design, e.g., low body drag. The aeroplane was only available for a short time and the tests were not, therefore, of a very comprehensive nature. The opportunity was, however, taken to include in the tests sufficient measurements from which, with the assistance of the available engine data, the performance of the aeroplane could be estimated and compared with the measured flight performance. This provided an interesting check on how far the analysis of tunnel tests on a complete aeroplane with wings extending beyond the jet boundaries could be usefully employed in predicting performance.

The drag of the Gauntlet body, including cowled engine, tail unit and undercarriage (less wheels), was 53.0 lb. at 100 ft./sec. With the engine removed and replaced by a faired nose the drag was 40.3 lb. The corresponding drag coefficients based on wetted area, i.e., total surface area, are 0.0126 and 0.0096, and the corresponding ratios of drag coefficient to equivalent flat plate skin friction are 4.8 and 3.7.

A drag estimate (at zero lift) of the complete aeroplane was made from the tunnel tests where the wings were projecting beyond the jet boundaries; the estimated drag was 111.8 lb. at 100 ft./sec., and the wetted area drag coefficient ratio 3.1. All these figures show that the drag is appreciably greater than for modern clean monoplane design.

The top speed of the aeroplane estimated from the tunnel drag tests and the engine test bed power data was 234 m.p.h. at 15,000 ft., compared with a measured speed of 230 m.p.h.

It appears that if the actual engine power developed at altitude is known the top speed performance of an aeroplane can be estimated with a fair degree of accuracy from drag tests in the 24 ft. tunnel even when the wings project outside the jet boundary; this conclusion must be treated with reserve until further evidence from similar experiments is collected.

FORCED OSCILLATIONS OF AEROPLANES, WITH SPECIAL REFERENCE TO VON SCHLIPPE'S METHOD OF PREDICTING CRITICAL SPEEDS FOR FLUTTER. By R. A. Frazer, B.A., D.Sc., and W. P. Jones, B.A. R. & M. No. 1795. (26 pages and 22 diagrams.) October 21, 1936. Price 3s. 6d. net

The subject of the forced oscillations of aeroplane structures has assumed importance in recent years in relation to the prediction of critical speeds for flutter. The present paper deals principally with a method proposed by von Schlippe, in which the aeroplane is given forced oscillations in flight and the critical speed for flutter is estimated from measurements of the maximum forced amplitude corresponding to various flight speeds. The main purpose of the investigation is to examine whether the method would give reliable estimates of the critical speed if the measurements were restricted to flight speeds well removed from the actual critical speed.

Part 1 describes the theoretical behaviour of a model wing which is subjected to forced oscillations at various airspeeds below the critical speed. Part 2 summarises the results of some wind tunnel experiments. The Appendix deals with the general theory of the forced oscillations of dissipative systems which obey linear laws.

The conclusions of the report are as follows :—

(i) When the damping forces are large, the forcing frequencies corresponding to maximum forced amplitude depend on the particular co-ordinate chosen for observation of the motion. The term *resonance* is, in general, inapplicable to such systems.

(ii) A dynamical system with two degrees of freedom can show at most three maxima of forced amplitude. More generally, with a system having n degrees of freedom the greatest number of maxima is $2n - 1$ (see (v) of the Appendix).

(iii) In the case of an aeroplane wing the complete "Schlippe diagram showing the *maxima* of forced amplitude plotted against airspeed comprises several curves, one or more of which may end or begin abruptly at particular speeds.

(iv) The critical speed for flutter cannot in general be estimated satisfactorily by von Schlippe's method, unless some measurements of maximum forced amplitude corresponding to airspeeds close to the critical speed are included.